THE APPLICATION OF MULTIPLE FACTOR ANALYSIS TO THE AGGREGATE DEMAND FOR DAIRY PRODUCTS

by

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A THESIS

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics

1951

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ABSTRACT

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The objectives of this study were:

1. To analyze economic data concerning economic conditions in general, and dairy products in particular, by means of multiple factor analysis in order to investigate what factors were operative during the two time periods of 1929-1948 and 1929-1941.
2. To determine how well these factors could explain and predict the disappearance of various dairy products, by setting up multiple regression systems based on the factor analyses.

An evaluation of the applicability of the method of multiple factor analysis to economic data was also made.

There were 76 variable included in this study. These were composed of aggregate U. S. data on a monthly basis. These variables were grouped in several different ways. One group combined all variables relating to general economic conditions while other groups covered prices, fluid milk and cream, butter, cheese, condensed, dry and evaporated milk, the production and disappearance of dairy products, and marketing margins. Separate factor analyses were made of each of these groups for the two time periods.

The factor analysis of general economic conditions showed two distinct factors. These were a general price level factor and an industrial activity factor. The analyses of dairy products showed that the general price level factor explained most of the variations in the wholesale and retail prices of the dairy products. Some of the real wholesale prices were explained by the industrial activity factor, but several real wholesale and real retail prices

were found to be independent factors or were indeterminate in structure in these analyses. A milk production factor showed that the production of most dairy products followed the seasonal trend of milk production, although butter production did not follow this trend. Similar factor structures were derived in the factor analyses of the separate time periods, although sharp differences were found in some cases.

Regression systems were set up to investigate how well the factor structures explained the disappearance of individual dairy products. These regression systems were based on the factor structures; the disappearance was the dependent variable in each system, while the independent variables were selected from the factor structures. The coefficients of multiple correlation derived from these systems varied from r = .88 to r = .51. Thus, although in some cases the regression systems based on the factor structures yielded fairly good results, these results were quite poor in other cases. The failure of the regression systems to explain the variations in the disappearance data was probably due to the selection of the variables for the factor analyses, to errors in the basic data, and to the time periods used in these analyses.

There were several serious weaknesses shown by the application of multiple factor analysis to economic data. In many cases indeterminate factor structures were obtained. In some cases conflicting results were obtained from different factor analyses. The use of two different time periods showed that different factors could be obtained from the use of different time periods.

In conclusion, it was felt that factor analysis could prove to be a useful tool in empirical economic analysis for use with unexplored data. Further study is necessary before its value in the estimation of demand relationships can be properly evaluated.

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ACKNOWLEDGEMENT

The author expresses her sincere appreciation to all who helped in the preparation of this manuscript. Valuable assistance was given by Dr. Leo Katz of the Department of Mathematics in the statistical portions of this research. Dr. Katz and Dr. L. W. Witt of the Department of Agricultural Economics read the manuscript and made many suggestions which were gratefully appreciated.

The author especially wishes to thank Dr. G. G. Quackenbush of the Department of Agricultural Economics. His guidance and background experience and the generous amount of time which he expended on this manuscript helped to make it a better and more integrated piece of work.

The statistical assistance given by Mrs. Mary Hudson and Mrs. Frances Root of the clerical staff of the Department of Agricultural Economics was an invaluable aid in the completion of this work. The author, of course, assumes complete responsibility for any errors which may be present in the manuscript.

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I. INTRODUCTION

Dairy products are the largest single source of agricultural income in the United States. They also account for almost one - fifth of the total amount spent for food by civilian consumers. Thus dairy products comprise an extremely important segment of the economy for both producers and consumers.

The total milk production on farms is utilized in the production of many products, and this total production is relatively fixed over short periods of time. It is desirable to allocate this production among the various products in order to obtain the maximum satisfaction for consumers and the maximum revenue for producers. It is also desirable to determine what prices should exist in order to bring about these optimum positions.

The problems of allocation of milk supplies and pricing of dairy products have been intensified within the past few years by the institution of federal milk marketing orders in many areas of the United States. These milk marketing orders have been for the purpose of providing orderly and dependable milk supplies for these areas, and have principally taken the form of establishing pricing formulas for various classes of milk. The pricing formulas have generally been based on various economic indices without too careful an analysis of the relationships involved. Most of them have been empirically determined and, although it might suffice in the short run,

this type of analysis leaves much to be desired on theoretical grounds and for long run considerations as well. The ability to forecast the demand for dairy products would be a significant contribution toward the problem of allocation of raw milk supplies. The knowledge of what factors affect dairy product prices, and how these prices affect the demand for these products, would aid not only in the establishment of federal order regulations but also would aid individual organizations in the policy questions of price formulation.

Review of Literature

Many studies have been made concerning demand and price relationships for various dairy products. Most of these have concerned specific regions or markets, although a few have been on an aggregative basis. The studies relating to specific markets have relied mainly on information obtained from surveys of consumers and/or milk dealers and many have been reported as simple compilations of the data. A study of this type is the one by Blanford (2) concerning consumer purchases of fluid milk in New York City. His results are based on tabular analyses, using simple differences in purchases of fluid milk in relation to prices in different areas and different sources of these purchases.

Some regional and market studies have estimated the demand and supply for dairy products by means of multiple correlation analyses. An early study by Ross (8) used multiple correlations to show the effects of various selected factors on the sales of

fluid milk in New York City. Waite and Howe (15) used correlations in estimating the demand for fluid milk in six New Jersey townships, while Gaus (5) used multiple correlation analysis to estimate milk deliveries in Vermont. A recent study by Pritchard (7) estimated the demand for fluid milk in Indianapolis. The system giving the highest coefficient of correlation in this latter study included indices of the average retail price of milk in Indianapolis, the B.L.S index of retail commodities, an index of per capita disposable income, and an index of lagged income. The selection of these indices was based primarily on the judgment of the investigator.

Relatively little has been done on the analysis of aggregate demand for dairy products. The most important recent work has been done by the Bureau of Agricultural Economics of the U. S. D. A. (1,6) where a simple correlation between annual per capita expenditures for fluid milk and cream and annual per capita disposable income has yielded good results. The rationale for this system is stated as follows: "Expenditures by consumers for fluid milk and cream are directly related to consumers' earnings. Consumer purchase studies have also demonstrated the close association between expenditures for fluid milk and cream, as well as quantities purchased, and consumers incomes" (6). Similar studies for butter, cheese, and evaporated milk have also been made (1).

These studies involve expenditures for dairy products, which consist of both quantities consumed and prices. Shepherd (10) has estimated the demand for butter using these variables specifically. In one system he has shown the

regression of retail butter prices on disposable income, butter consumption and time, and in another he has shown the regression of retail butter prices on retail expenditures for food, consumption and time. All of these aggregate studies have used annual data.

Purpose and Method of Procedure

The purpose of this study was to determine what the factors are that affect the aggregate demand for individual dairy products and to utilize these factors to estimate the demand for these products. Heretofore the important factors affecting demand have been selected by investigators on the basis of theory, previous knowledge, and intuition. This study investigated the possibility of putting this process of selection on a sounder foundation, by applying the method of multiple factor analysis to the data.

The method of multiple factor analysis makes it possible to analyze large bodies of data and determine what relationships exist among these data. Therefore it was decided to apply it to the large body of data available for dairy products in order to investigate the similarities and differences which exist among these data. Although some of the data included herein have been analyzed and compared in previous studies, this has never been done on a similar scale.

There were 76 individual indices included in this study. These were composed of aggregate U.S. data on a monthly basis, covering in one case the period 1929-1941 and in another, the

period 1929-1948. These data included prices (retail, wholesale, and real) production and disappearance of individual dairy products, total milk production, the milk-feed and butterfat-feed ratios, marketing margins on dairy products, and various indices of general economic conditions including among others the consumers price index, employment and payrolls in manufacturing industries, industrial production, and consumer credit. (A complete list is given in Table III.)

These data were grouped in several ways in this study. One grouping consisted of all indices relating to general economic conditions. Another combined all the price series. Still others referred specifically to Fluid Milk and Cream, Butter, Cheese, Evaporated Milk, Production and Disappearance of Dairy Products, and Marketing Margins on Dairy Products. Each of these groupings contained from 20 to 40 series of data. A factor analysis was then applied to each to investigate the underlying factors which were present in each grouping. An interpretation of each group was made, analyzing the factors and discussing the relationships of the variables to the factors and to each other.

The method of multiple regression was used to estimate the demand for the individual dairy products. The number of variables to be used in each regression was determined by the number of factors present in the group under consideration. The selection of the variables in the regression also depended on the factors present.

In summary, this study investigated the factors which

influence the demand for dairy products. The method of multiple factor analysis was used to determine what these factors are. The results of the factor analyses for the individual dairy products then became the basis for multiple regression systems for estimating the demand for these dairy products. In addition, an evaluation was made of the application of multiple factor analysis to data of this particular type and to economic data in general.

Source and Adequacy of Data

The data used in this study were gathered from various governmental agencies such as the Department of Agriculture, the Department of Commerce and the Department of Labor. The degree of accuracy of much of this data is questionable, as many approximate measures have been used in deriving these series due to the unavailability of the exact data. However, these were the best data that were available for this work and it was assumed herein that, although the exact figures might be inaccurate, the directions of change (increases or decreases) were consistent with actual changes. This should have been sufficient for the determination of the factors influencing demand, even though the actual estimates of demand would obviously be dependent upon the size of the changes as well as the directions of change.

Several compromises were necessary in this study in the practical aspects of dealing with such a large body of data.

First, compromises were made in the selection of data, since many of the desired series were not available in the necessary form or for the necessary period of time. For example, the index of disposable income could not be included as it is only published quarterly. Therefore, the monthly index of payrolls in manufacturing industries was included instead. A second compromise was necessary in the statistical aspects of this study. Since the manual labor involved in obtaining statistics from the basic data would be prohibitive, the data were coded for I.B.M. tabulations. This reduced a large part of the labor involved. A complete description of the indices included in this study and the way these indices were processed is given in section III.

II. METHODOLOGY

General Aspects

The validity of economic studies utilizing simple and multiple correlation analysis has depended primarily upon the selection of the variables and the manner in which these variables have been treated.

The selection of variables has usually been based on theoretical economic concepts, information already available on the problem from various sources, and on the knowledge and judgment of the investigator. The inclusion or exclusion of data has had a crucial effect on the results obtained, with the decisions in this respect depending entirely upon the discretion of the investigator.

In a correlation analysis, one variable is considered as being dependent upon the remaining variables, or as being determined by the remainder. The selection of the dependent variable has usually been governed by the nature of the problem, with the discretion of the investigator again being of major importance. It can be noted here that some studies (9) have been made with first one, and then another, variable considered as dependent (i.e. consumption considered as dependent with price as the independent variable and then price considered as dependent with consumption as the independent variable) and the result selected which yielded the highest coefficient of correlation. Although this procedure provides a more

significant result statistically, it is questionable how much economic significance it contains.

It has also been shown (4) that the independent variables must be uncorrelated amongst themselves and be truly independent of each other in a multiple correlation analysis. Otherwise, spurious results arise where it is impossible to tell how much of the correlation is due to the relationship between the dependent and independent variables, and how much is due to the relationship between the independent variables.

An investigation of the relationships between variables using economic data was developed by Frisch (4) known as the technique of confluence analysis. This technique starts with two variables and successively adds further variables, investigating the resulting relationships after each addition. These relationships indicate whether the added variable is essential to the relationship, unessential or immaterial to the relationship, or actually detrimental to it. The technique of confluence analysis has been used by Tinbergen in business cycle analysis (13), and by Stone (11) in the analysis of price-consumption relationships.

Confluence analysis and multiple factor analysis are similar in that they both seek to determine significance among variables; however, whereas confluence analysis builds up significant variables by analyzing them one at a time, factor analysis analyzes all variables at the same time, shows the various relationships between them, and also provides a method for estimation purposes. Factor analysis should prove

to be a more powerful technique than that of confluence analysis, since it provides more information concerning the variables.

The method of multiple factor analysis avoids some of the pitfalls of correlation analysis and confluence analysis. No one variable is chosen as dependent upon the remaining variables; all of the variables are considered simultaneously. Simple correlations are found between each pair of variables; these correlations are then analyzed to discover any underlying relationships which exist. The object is to be able to explain the correlations between these variables by a smaller number of variates, or factors, which can be considered as clusters or combination of the original variables. These clusters can show which variables are related in each factor, how the factors are related to each other (i.e. whether they are independent of each other or closely connected) and how important each factor is in the explanation of the various original variables. It is then possible to combine the factors obtained into a regression system for estimation purposes.

For example, a number of measurements might be taken from several different people. These measurements could include such things as height, weight, length of arm, chest expansion, size of head, upper forearm, thigh, pulse rate, etc. A factor analysis of all these measurements would probably show that two underlying factors were involved, a body build factor and a metabolic rate factor. Thus all of the measurements might have been explained in terms of these two factors, and it

would be possible to determine which of these factors had the largest influence in any one variable of body measurement. It could also be seen whether the two factors of body build and metabolic rate were independent of each other or to what extent they depended on each other. After the two factors were determined, a regression system could be set up for estimating the various body measurements.

The problem of selection of data is present in factor analysis as well as in correlation analysis; however, it is not as important in the former as in the latter. This is mainly because more variables can be included in a factor analysis than are usually included in a correlation analysis; the techniques of factor analysis can more easily accomodate a larger number of variables than a correlation analysis. In a factor analysis twenty to thirty variables can be included without too much difficulty; factor analyses have been made using from fifty to one hundred variables, although these have resulted in very cumbersome procedures. In a multiple correlation, on the other hand, four or five variables can be included without too much difficulty, but any larger number results in long and involved manipulations. Since more variables can be utilized in a factor analysis, the importance of each is correspondingly decreased. The significance of including extraneous variables in a factor analysis, or conversely of excluding essential variables, will be discussed later.

Theory of Multiple Factor Analysis

The techniques of multiple factor analysis were first applied in the field of psychology. They were applied to large batteries of tests, in an attempt to determine basic human abilities or traits. However, the techniques are applicable to almost any body of related information if the theoretical criteria discussed below can be satisfied.

Factor analysis assumes that there is an underlying order in any collection of data relating to a specified field, and that this order can be expressed, at least in part, by a relatively smaller number of variates than the original number. These variates have been called 'factors', 'causes', 'functional unities', or 'independent measurements', depending on the context and on the preferences and philosophies of the investigators in the studies under consideration. They will be called 'factors' hereafter in this study, since this term carries fewer connotations than the others.

The assumption of an underlying order is essential to the theory of factor analysis. This order is not one which would enable one to distinguish between dependent or independent variables; it is, instead, an order which gives one the ability to describe a large number of variables by a lesser number. This could not be done if it were assumed that all the original variables were completely independent of the others, or that they were independently determined. This lesser number of variates, or factors, is assumed to be able to

account for the variations in the entire number of original variables.

Before the variables are analyzed, a table of intercorrelations is set up. Each intercorrelation is a simple, linear correlation between two variables; the table of intercorrelations shows the simple correlation between each pair of variables. This table of intercorrelations is called the correlation matrix. The correlation matrix is the basis for all further analysis in determining the desired factors. A correlation matrix is shown in Figure 1a.

1a

Variables	1	2	3	....	n
1	1	r_{12}	r_{13}	....	r_{1n}
2	r_{21}	1	r_{23}	....	r_{2n}
3	r_{31}	r_{32}	1	....	r_{3n}
.	.	.	.	....	.
.	.	.	.	....	.
.	.	.	.	....	.
n	r_{n1}	r_{n2}	r_{n3}		1

1b

Variables	1	2	3	....n
1	1	r_{12}	r_{13}	....r_{1n}
2		1	r_{23}	....r_{2n}
3			1	....r_{3n}
.				.....
.				...
.				..
n				1

Figure 1. Illustration of a Complete Correlation Matrix

This table is symmetric, as the intercorrelation between variables 1 and 2 (r_{12}) is the same as that between variables 2 and 1 (r_{21}). Using a general notation, $r_{ij} = r_{ji}$; thus it is only necessary to present half of the table of intercorrelations to have the complete set of information. In general,

the correlations above the diagonal will be presented with the lower half left blank, as in Figure 1b. It will be noticed that the diagonal elements are all unity. This is true because there is perfect correlation in any variable with itself.

The assumption of an underlying order within the correlation matrix leads to the further assumption that the variations in any variable can be explained by means of underlying factors. Each variable is assumed to consist of three types of component factor parts: common factors, which are found in several, or perhaps all, of the variables; a specific factor, which is unique in the individual variable; an error factor, to account for errors in measurement of the variable. Since the specific factors and the error factors are not measurable individually they are combined into a unique factor, which is not shared with any other variable. A complete factor matrix is shown in Figure 2.

	Common Factors			Unique Factors				
	I	II	III	1	2	3	.....	n
1	a_{11}	a_{12}	a_{13}	u_{11}				
2	a_{21}	a_{22}	a_{23}		u_{22}			
3	a_{31}	a_{32}	a_{33}			u_{33}		
.	.	.	.			.		
.	.	.	.			.		
.	.	.	.			.		
n	a_{n1}	a_{n2}	a_{n3}					u_{nn}

Figure 2. Illustration of Complete Factor Matrix

The value a_{11} shows the weight of common factor I in variable 1, a_{12} shows the weight of common factor II in variable 1, a_{13} shows the weight of common factor III in variable 1, etc. The significance of these factor weights will be discussed in a subsequent section.

The sum of squares of the weights of the common factors for any one variable, plus the square of the weight of the unique factor, comprise the total variation of that variable. It is also the equivalent of the unit variance to be found in the diagonal of the complete correlation matrix; i.e.

$$(a_{11})^2+(a_{12})^2+(a_{13})^2+(u_{11})^2 = 1$$

or, in general notation:

$$(a_{i1})^2+(a_{i2})^2+(a_{i3})^2+(u_{ii})^2 = 1$$

where $\underline{i}$ is any variable from 1 to $\underline{n}$.

The sum of squares of the factor weights, or loadings, of the common factors alone for any single variable is known as the <u>communality</u> of that variable. This gives the amount of the variance of each variable which is explained by these common factors alone. The communality of any variable $\underline{i}$ is denoted h_i^2, where:

$$h_i^2 = (a_{i1})^2+(a_{i2})^2+(a_{i3})^2 \quad (\leq 1)$$

The communality is less than or equal to one since the unique factors are omitted. Actually,

$$h_i^2+u_{ii}^2 = 1$$

As the unique factors become smaller, the communalities approach unity.

The matrix multiplication of the complete factor matrix

(the matrix of common factors and unique factors) by its transpose[1] exactly reproduces the complete correlation matrix of Figure 1. This corresponds to the theoretical assumption that the underlying factors are sufficient to explain and reproduce the variations of all the original variables. Using the common factor matrix alone, the original correlation matrix can be reproduced with the exception of the diagonal elements. The diagonal elements which do appear are minus the effects of the unique factors; they are the communalities mentioned above. The product of the factor matrix and its transpose is called the reduced factor matrix. It is shown in Figure 3.

	1	2	3	....	n
1	h_1^2	r_{12}	r_{13}	....	r_{1n}
2	r_{21}	h_2^2	r_{23}	....	r_{2n}
3	r_{31}	r_{32}	h_3^2	....	r_{3n}
.	.	.	.	....	.
.	.	.	.	....	.
.	.	.	.	....	.
n	r_{n1}	r_{n2}	r_{n3}	....	h_n^2

Figure 3. Illustration of Reduced Factor Matrix

Computation of Factors

Theoretically the complete factor matrix exactly reproduces the correlation matrix, However, there is no need for

[1]The transpose of a matrix A, denoted A', is a matrix in which the successive rows of A have become the successive columns of A'. For a more complete description, see Thurstone (12).

the complete factor matrix; interest centers on the common factor matrix, which involves all variables, rather than on the unique factor matrix which shows the unique factor for each variable. Actually, it would be sufficient to consider the common factor matrix alone, since it does reproduce the original correlation matrix with the exception of the diagonal elements (see Figure 3).

However, the matrix which exists at the beginning of the analysis is the correlation matrix without adjusted diagonal elements. The problem is to estimate these adjusted diagonal elements, the communalities, and to derive a factor matrix which can reproduce the given matrix.

There are several possible methods for estimating the communalities of the variables. One of the simplest methods is to adopt the highest correlation in any row (or column) as the communality for the variable represented by that row (or column). This selects the highest correlation among all the correlations for any one variable as the communality for that variable.

The estimation of communalities is quite important, since if the estimate is too high, some of the unique factors are included and thus too many factors are included in the analysis. Too low an estimate for the communalities likewise

yields incorrect results. However, the method described above has been found satisfactory for most studies.

One method of estimating factors is the centroid method. The centroid method for determining one factor is as follows: if several variables seem to form a similar group, all having high intercorrelations amongst themselves and low intercorrelations with the rest of the variables, this group can be considered as a factor. (The actual grouping of variables may be purely arbitrary. The results do not depend on this grouping process.) This factor can be computed, and its effect eliminated from the original correlation matrix. The remainder is called a residual matrix, which is the same type of matrix as the original correlation matrix, except that the correlations shown are usually smaller, since the effects of one of the factors contained in the original correlation matrix have been removed. In this residual matrix, the communalities can be reestimated; this increases the precision of estimation. If the first factor has explained all the variation in the original correlation matrix, the correlations remaining will approximate zero; however, if high intercorrelations still remain, the residual matrix is analyzed in the same way as the original correlation matrix, to investigate whether any further groupings can be found signifying further factors. This process continues until the residual matrix approximates zero.

Interpretation of Factors - Two Factor Example

A geometric interpretation of factors gives the clearest conception of the relationships which exist among the variables and the factors.

Independent factors are assumed to be orthogonal to each other, having no influence upon each other. The factor matrix which is determined by the previously described centroid method is composed of these orthogonal factors, since the effect of each factor is removed individually. In the multiple centroid method, the factors determined simultaneously are later transformed into orthogonal factors.

The following example from Thurstone (12, pp. 87-89) will illustrate some of the geometric concepts involved. A sample factor matrix of two factors is shown in Table I. These two factors are assumed to be derived from an intercorrelation table from eight variables, with communalities along the diagonal. This intercorrelation table is given in Table II.

Since the factor matrix is orthogonal, the factor loadings can be graphed directly. The graph of these factors is a factor structure, as shown in Figure 4. As can be seen, Factor A is in one direction while Factor B is orthogonal to it; variables 2 and 5 involve only Factor A, variables 6 and 8 involve only Factor B, and variables 1, 3, 4 and 7 are combinations of both A and B. Variable 2 is almost totally explained by Factor A. If variable 2 were completely explained by Factor A its factor loading on A would be 1.00;

since its factor loading on A is only .90, there is still some part of its variation not explained by that factor. However, Factor B cannot explain any of the variation in variable 2; the factor loading of variable 2 is .00 for Factor B. Variable 5 is likewise only explained by Factor A and not influenced at all by Factor B; however, less of its variation is explained by Factor A than is variable 2.

Variables 1 and 4 are explained by both Factors A and B. They are more explained by A than B, however, since their projections in the A direction are greater than those in the B. direction. Variables 3 and 7 are also explained by both A and B, but more by B than by A.

Actually, A and B are not factors; they are called reference vectors. They provide the axes, or the orientation, for the configuration of variables. This configuration could be drawn without axes, as in Figure 5. The configuration remains fixed; the variables retain the same relationship to each other in this same pattern. The selection of reference axes is purely arbitrary. For example, the axes could be rotated in various directions and located as in Figure 6. In each of these rotations a new factor matrix is derived.

The reference axes are selected so as to make the structure as simple as possible. If several variables are colinear, or cluster in the same direction, it is desirable to place one reference axis in that direction, since all these variables could then be explained by the one reference vector rather than by several. This can be illustrated by Figure 6.

Table I. Example of a Factor Matrix

Variables	A	B
1	.70	.30
2	.90	.00
3	.40	.60
4	.60	.30
5	.50	.00
6	.00	.60
7	.30	.80
8	.00	.80

Table II. Example of a Complete Correlation Matrix with estimated communalities

Variables	1	2	3	4	5	6	7	8
1	.58	.63	.46	.51	.35	.18	.45	.24
2	.63	.81	.36	.54	.45	.00	.27	.00
3	.46	.36	.52	.42	.20	.36	.60	.48
4	.51	.54	.42	.45	.30	.18	.42	.24
5	.35	.45	.20	.30	.25	.00	.15	.00
6	.18	.00	.36	.18	.00	.36	.48	.48
7	.45	.27	.60	.42	.15	.48	.73	.64
8	.24	.00	.48	.24	.00	.48	.64	.64

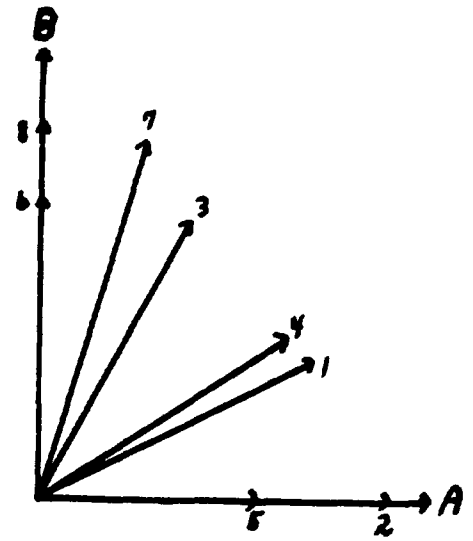


Figure 4. Example of Factor Structure obtained from Factor Matrix in Table I.

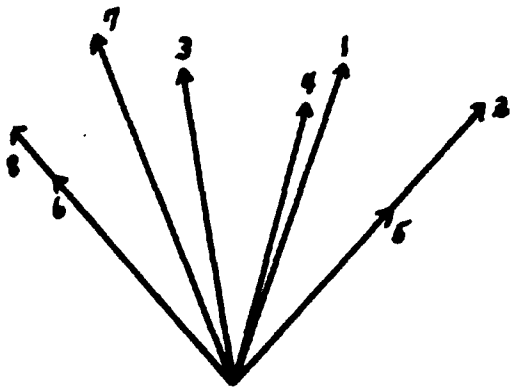
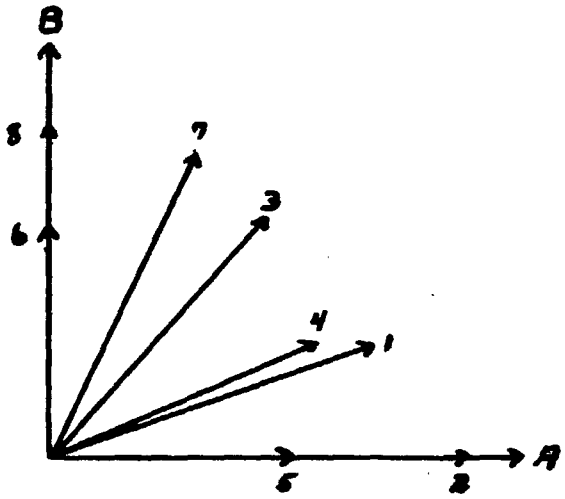
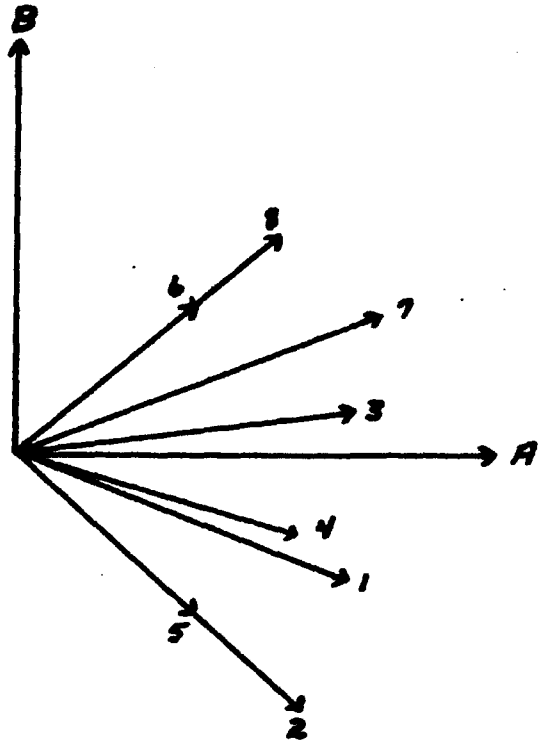


Figure 5. Example of a Variable Configuration

a. Factor Structure I



b. Factor Structure II



c. Factor Structure III

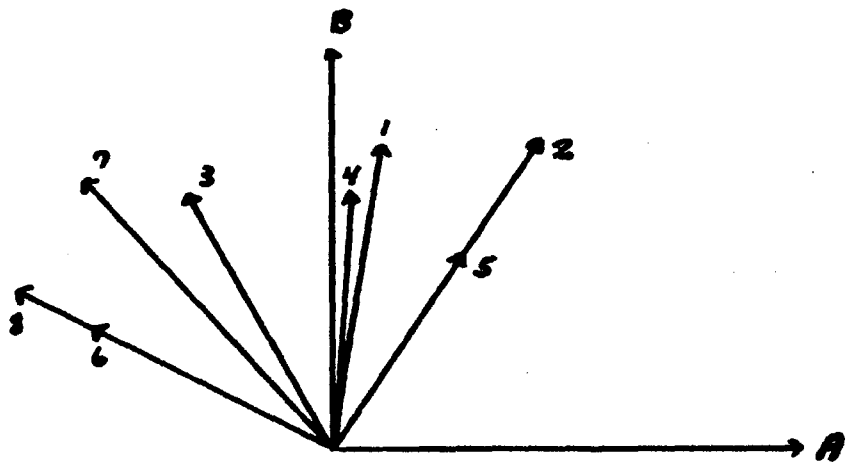


Figure 6. Examples of Different Possible Factor Structures from One Configuration

In Figure 6a variables 2 and 5 can be explained in terms of A alone, while variables 6 and 8 can be explained in terms of B. alone. In Figure 6b all of these variables can only be explained in terms of both A and B.

This difference in the location of reference axes is very important. Since the selection of reference axes is purely arbitrary, there is no absolute way of determining what factor is represented by reference vector A. However, if reference vector A alone is found in several variables and explains a large part of the variation in those variables, they can be analyzed to see what similarities they possess and what single explanatory concept connects them all. This concept becomes the basis of Factor I. Thus the identification of the factor depends on the investigator; it is his job to analyze the variables which cluster together and determine what the unifying concept is, and hence what the factor is.

There is another consideration in the location of the reference vectors, especially in regard to economic data. In addition to identifying the unifying concept comprising any single factor, it is desirable to select one variable which best typifies that factor, for further investigation and for estimation purposes. This variable is the one which lies closest to the reference axis and has the longest projection on that axis (hence having most of its variation explained by that reference vector alone).

The amount of explained variation of any variable equals the sum of squares of the factor loading of that variable.

Thus the explained variation for variable 1 in the above example (see Table I) is $(.70)^2 + (.30)^2$, which equals .58. Since the total variance for any variable equals unity, the unexplained variance for variable 1 is .42. These may also be put in terms of percentages; thus, 58% of the variation in variable 1 is explained by Factors I and II, while 42% is not. The unexplained variance may be caused by specific factors occuring only in this variable or by errors in the measurement of this variable.

The amount of explained variation remains the same no matter how the reference axes are rotated. This is true since the configuration between the variables remains the same. It can also be noted that the amount of explained variance of each variable is equal to the communality of that variable.

In summary, the factor matrix is an orthogonal matrix. It can be graphed, with the graph giving the fixed configuration existing between the variables. The first graph depends on a pair of reference axes which are determined by the method used to derive the factor matrix (which in most cases arbitrarily determines the location of the axes); these reference axes can be rotated to obtain the best factor structure, with as many variables as possible located on these axes and with as large projections as possible on these axes. The amount of explained variation for any one variable is equal to the sum of squares of the factor loadings of that variable; the unexplained amount equals one

minus the explained amount. The unexplained amount may be due to specific factors or errors in measurement of the variable. It is up to the investigator to determine what the unifying concept is for any one factor and to select the variable which best typifies that factor for use in estimating equations.

Extension to More Than Two Factors

The above example has dealt with a factor structure in two dimensions, signifying two factors. This may also be extended to three factors, or, geometrically, a three-dimensional structure. Although it is more difficult to illustrate geometrically, all the concepts which apply to two factors are also applicable to three. Independent factors are orthogonal, the axes must still be rotated to obtain the best factor structure, the explained variance is the sum of squares of the factor loadings, and the investigator must still decide what the factors represented actually are.

When the number of factors goes beyond three, the geometric analysis breaks down completely. However, theoretically four factors span a four-dimensional space, five factors span a five-dimensional space, while n factors span an n-dimensional space. The same factor concepts are still applicable as in the case of fewer numbers of factors.

The graphic technique described above shows how the refer-

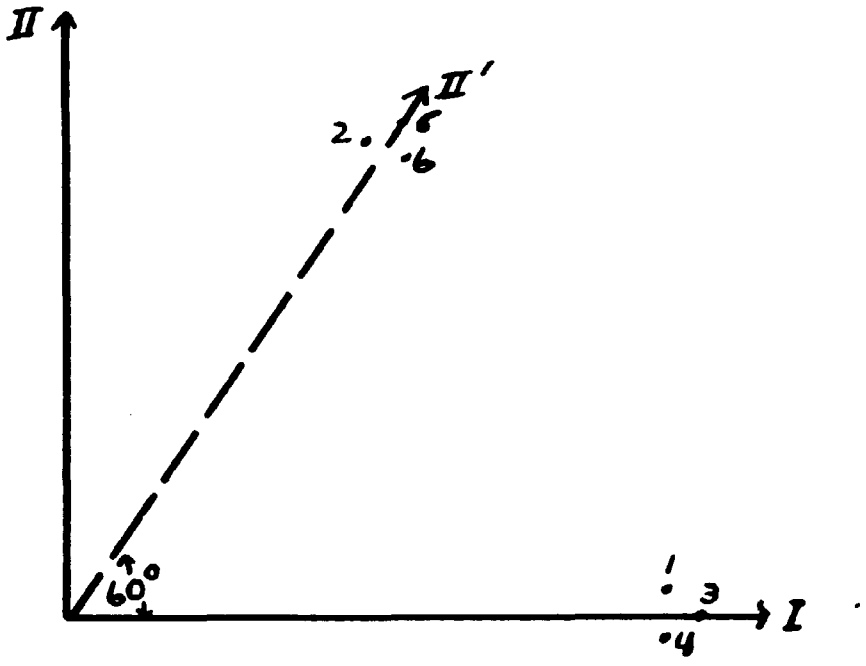
ence axes are located to get the best structure possible for two factors. (See Figure 6. The best structure is shown by Figure 6a.) When three or more factors are present this same technique may be used with but a slight modification. Each pair of common factors are graphed, and the rotation of axes accomplished in a series of rotations, adjusting first one reference axis and then another until the best structure is found for all the factors.

Correlated Factors

Until this time only completely independent factors have been considered, represented by orthogonal reference axes. However, this restriction is unnecessarily severe, especially in regard to economic data. Basic factors might be, and probably are, correlated in economic data. By removing the restriction of strictly orthogonal reference vectors it is possible to discover whether or not the basic factors are correlated and, if so, how closely they are correlated.

This may be done by deriving the best structure possible for the factors without the restriction that the reference axes are orthogonal to each other. If it appears that a cluster of variables determines a reference axis at an acute or obtuse angle to another axis, this is investigated. If the new structure derived is better than the structure derived with orthogonal axes, it is accepted. The angle between the axes signifies the strength of the correlation between the factors.

7a. Rotation 1



7b. Rotation 2

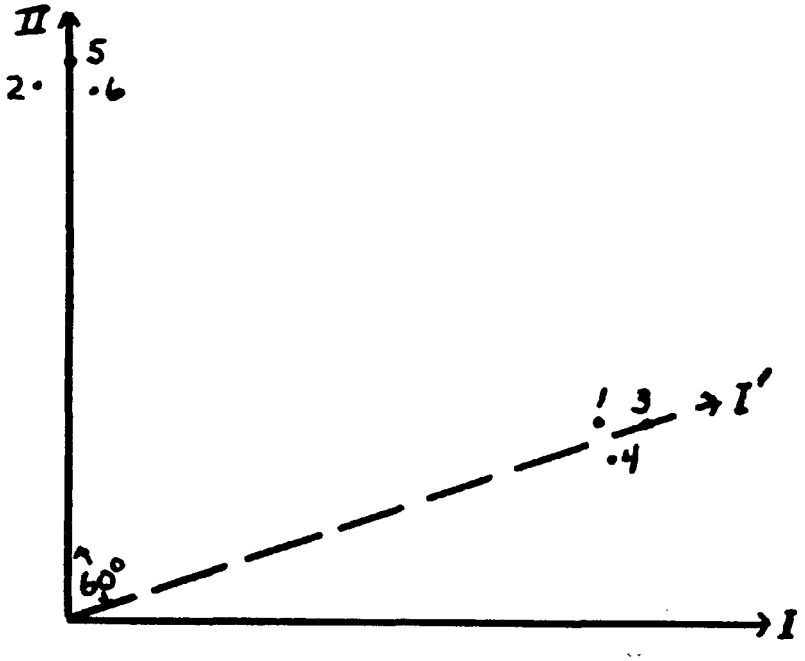


Figure 7. Example of a Rotated Factor Structure

A hypothetical example is set up in Figure 7. This shows that one cluster of variables may locate reference axis I, but an axis orthogonal to I will have little meaning as far as the second cluster of tests is concerned. Rotating reference axis II to II' will improve the structure; it also shows that the two factors located by these two reference axes are correlated with each other.

It does not matter whether the orthogonal axes are located as in Figure 7a or as in 7b. In Figure 7a, reference axis I goes through the cluster of 1, 3, 4 and II must be rotated to go through the cluster 2, 5, 6. In Figure 7b, reference axis II goes through the cluster 2, 5, 6 and I must be rotated to go through 1, 3, 4. The end result, however, gives the two axes with the same angle of separation. This also illustrates the point that it does not matter in what order the reference axes are rotated. Since the configuration of variables remains fixed, the end results are the same no matter what order of rotation is used.

Inclusion of Data

The original variables are explained in terms of a smaller number of common factors which are found in several, if not all, of these original variables. It can be seen if an extraneous variable is included, since the common factors will explain very little of the variance of this variable and most of its variance will be left unexplained. This

unexplained variance will be due to an unique factor in this variable.

However, if several new variables which contain the same, but previously unique, factor are added to the matrix, this factor would then become a common factor found in the otherwise extraneous variable and the newly added variables. It would be added to the common factors derived prior to the inclusion of the new variables. The importance of this new common factor could then be investigated.

Thus, if extraneous variables are included in the analysis, they can be identified as such and eliminated. However, the inclusion of new variables might show this extraneous variable to contain a common factor after all. Also, the inclusion of new factors might change the importance of previously determined factors in relation to the variables in the analysis.

One further point is pertinent here. If it is found that very little of the variance of a variable has been explained by the factors, there is nothing to indicate what further factors will explain this variance. The investigator might set up his study anew with revised variables, but this depends on his judgment alone. There is nothing in the method of factor analysis to aid him here.

Strengths and Weaknesses of the Method of Factor Analysis

The main strength of factor analysis is its ability to reduce a large number of variables to a smaller number, without losing any of the essential information. This smaller number of variables enables one to recognize the fundamental factors present in the large body of variables, since they are the basic component parts of the larger body. It is then possible to work with the factors rather than the complete number of variables.

There is value in being able to recognize what these basic factors are, and in analyzing how they fit into a theoretical framework. These factors can also be used for estimation purposes. The factor analysis aids in the selection of variables which best represent the various factors, and these variables can be used in standard regression systems. This method of selection of variables should be more reliable than that based solely upon the judgment of the investigator in setting up regression systems.

There are some weaknesses in the method of factor analysis itself. The most important of these are the estimation of the communalities, the rotation of the reference axes to obtain the best factor structure, and the identification of the factors. These are places where the investigator makes independent decisions which affect the over-all results. However, experience in the methods and techniques of factor analysis can reduce these weaknesses to a minimum.

More serious are the weaknesses which result from theoretical concepts. Factor analysis cannot be used to distinguish causes from effects. It shows what the primary factors are, and whether they are independent of each other or correlated in some way, but it is not designed to show casual relationships. Also, the method gives no indication of what variables should be included in the total number of variables in the analysis. These must be selected on the basis of theoretical concepts, independent information, and the judgment of the investigator. If a number of important variables are excluded from the analysis, the results obtained may or may not indicate that some variables are lacking. If they are subsequently included, and they are important to the analysis, the previously obtained results may be completely revised.

Factor analysis is based on a table of intercorrelations. Whenever time series are used in correlations a theoretical weakness exists since successive items are not independent of each other and serial correlations occur in the data. In other words, a price of one month depends on the prices of preceding months, in addition to other causal factors. This serial correlation in individual variables is assumed to be less than the intercorrelation between variables, however, so that time series can be used in correlations.

In using time series data for factor analysis, a factor structure is obtained for any given time period. In order

to obtain the same factor structures for two time periods, similar conditions have to exist for both periods. For example, a shift in demand could not occur without causing changes in the factor structure. Factor analysis over two time periods might be used to examine whether these changes had taken place and how they had affected different variables.

When a variable has factor loadings on more than one factor it is possible to describe the variable in terms of the factor which appears to influence that variable to the greatest extent. In terms of the example given earlier, where body build and metabolic rate factors were determined from body measurements, the chest expansion measurement might be said to be influenced primarily by the body build of an individual. However, knowing the metabolic rate of the individual would also be necessary before the chest expansion could be accurately determined. Thus the affects of all the factors would have to be considered before the total net effect could be determined.

It should be emphasized that the naming of the factors in a factor analysis is not a part of the factor analysis itself. The factor clusters are determined by the analysis, but the naming of the factors depends primarily on the investigator. The naming of the factors is most important in fitting these factors into a theoretical framework.

There are many ways of describing a factor structure. A cluster of variables determines a factor, which in turn

can be said to explain these variables. This is a kind of circular process, where the variables locate the factor and the factor explains the variables. Occasionally some variable might appear to be principally influenced by a factor in the factor structure when there is no logical correspondence between the variable and the factor. This could be due to a relationship which further study might uncover; it could also be due to an accidental relationship where the factor and the variable apparently followed the same trend due to different causes. Mis-naming a factor might also lead to a contradiction between factors and variables in the factor cluster. The judgment of the investigator plays an important part in deciding whether a factor 'influences' or 'explains' the variation in a variable or whether the factor and the variable in question follow the same trend due to an incidental relationship. This depends primarily on background knowledge concerning the area being investigated.

III. PROCEDURE

Basic Data Used

The data used in this study were aggregate statistics of the United States, published by the U. S. Department of Agriculture, Department of Commerce, and Department of Labor. Data on supply, disappearance and prices (both wholesale and retail) for the individual dairy products were included. Information was also included on general economic conditions, such as wholesale and retail price levels, department store sales, purchasing power, employment, etc. These will be enumerated in detail in a subsequent section.

Since so many variables were included, it was necessary to get a large number of observations for each variable. Due to the analysis used, it was also necessary to have these observations for comparable time periods. Annual data were not adequate, since many time series are only complete back to 1929; this would provide only twenty or so observations for each variable, and these would be too few to obtain consistent results for the number of variables involved. Consequently monthly data were employed for each variable.

The effects of different time periods in such a problem were considered, especially in regard to the war years. To investigate this, two different sets of analyses were made, utilizing the same variables but comprising two different time periods. The first covered the period from 1929 to 1941; the second covered the period from 1929 to 1948. Hence

the first begins with the boom year 1929, includes the depression period of the 1930's and the start of the up-swing at the end of the 1930's and the early 1940's, ending with the U. S. entry into World War II. The second includes all of the information of the first plus the World War II period and some of the period of post-war adjustments as well. These analyses will be discussed individually and then compared to discover the similarities and differences between the two.

There has been some criticism concerning the accuracy of the basic data used in this study. Much of this criticism is justified, since it is recognized that these data contain many errors. Some of these errors are due to interpretation concerning what should be included in or excluded from the data. Others are due to the unavailability of data due to a lack of records or the presence of non-comparable data. Still others are due to the attempt to cover the entire United States, thus raising the problems of sampling from such a large population and of covering the entire population satisfactorily.

These errors in the data are certain to affect the results of this study. However, if the errors are small relative to the reported statistics, the effects of these errors can be assumed to be at a minimum especially in regard to the factor analyses. This is true since small relative errors would have little effect on the correlations which are the basis

of the factor analyses. Even if these errors were relatively large, it would still be possible to test the applicability of the method of factor analysis to economic data, although the results of the factor analyses might change with revisions in the basic data.

The errors in the basic data become of greater importance when an attempt is made to forecast future events. Using incomplete or incorrect data cannot yield accurate results; the results will be in terms of these data. If a systemmatic bias exists in the data, i.e. a constant overestimation or underestimation, this would not seriously affect the results; however, this would not be the case if these errors are not systemmatic.

Description of Data

There are 76 variables included in this study. A complete description of these, including the sources from which they were obtained, is given in Table III. (The variables are numbered to 79, but 67 and 68 are combined in the one variable 67A while 69, 70 and 71 are the single variable 69A. This is due to the I.B.M. set-up.)

PRODUCTION: The total U. S. monthly milk production constitutes variable #1. Total monthly factory production of the various dairy products, butter, cheese, evaporated milk, condensed milk, dry whole milk, and dry or powdered skim milk constitute #2-7 and #42. Oleomargarine production, #8, has

also been included for comparison with butter.

PRICES: The average price per pound of butterfat, #9, and the average wholesale price per hundred pounds of milk, #10, have been included as general, over-all indicators of milk prices. The butterfat-feed price ratio, #11, and the milk-feed price ratio, #12, are included to investigate what relationships they might have with the other variables.

The average price to producers for fluid milk constitutes #13, while the average price to producers for manufactured products is #14. The average wholesale prices for the six previously listed dairy products are #15-18, #41 and 42, while the average retail prices for dairy products are #19-22. The average price per pound of uncolored oleomargarine is variable #23.

The general Consumers Price Index (i.e. Cost of Living Index), the Consumers Price Index for Foods, the Wholesale Price Index, and the Wholesale Price of Foods Index have been included in #24-27 to investigate their relationships with other variables.

Real wholesale and retail prices of the various dairy products comprise variables #43-51, 54-57. These were derived by dividing each actual monthly retail price by the corresponding monthly Retail Food Price Index (#25) and each actual monthly wholesale price by the corresponding Index of Wholesale Food Prices (#26).

Table III. Variables Included in this Study, giving Description and Source of Data

Variable Number	Description	Source
1	Milk, Production on Farms	B.A.E., U.S.D.A.
2	Creamery Butter Production	" "
3	Cheese, Total Factory Production	" "
4	Evaporated Milk, unskimmed case goods production	" "
5	Condensed Milk, skimmed, sweetened and unsweetened case goods and bulk goods production	" "
6	Dry Whole Milk Production	" "
7	Ice Cream Factory Production	" "
8	Oleomargarine Production	" "
9	Butterfat, average price per pound received by farmers	" "
10	Milk, average wholesale price per 100 pounds received by farmers	" "
11	Butterfat-feed price ratio	" "
12	Milk-feed price ratio	" "
13	Milk, average dealers buying price per cwt. for standard grade milk	" "

Table III. Variables Included in this Study, giving Description and Source of Data (Continued)

Variable Number	Description	Source	
14	Milk, average price per cwt. paid producers for 3.5 milk delivered at condenseries	B.A.E.,	U.S.D.A.
15	Cheese, fresh single daisies, average wholesale price per pound at Chicago	"	"
16	Cheese, American twins, wholesale price on Wisconsin Cheese Exchange	"	"
17	Creamery Butter, 92 score, average wholesale price per pound	"	"
18	Evaporated Milk, unsweetened, average wholesale selling price per case	"	"
19	Milk, fresh, delivered, average retail price per quart in leading cities	"	"
20	Evaporated milk, average retail price per 14½ oz. can in leading cities	"	"
21	Cheese, average retail price per pound in leading cities	"	"
22	Butter, average retail price per pound in leading cities	"	"
23	Oleomargarine, uncolored, average retail price per pound in leading cities	"	"

Table III. Variables Included in this Study, giving Description and Source of Data (Continued)

Variable Number	Description	Source	
24	Consumers Price Index for moderate income families in large cities	B.L.S.,	U.S.D.L.
25	Retail Food Prices in large cities	"	"
26	Index Numbers of Wholesale Prices in Foods (1926 = 100)	"	"
27	Wholesale Price Index of All Commodities (1926 = 100)	"	"
28	All Manufacturing Industries, Employment Index (1939 = 100)	"	"
29	All Manufacturing Industries, Payroll Index (1939 = 100)	"	"
30	Retail Cost of the Market Basket	B.A.E.,	U.S.D.A.
31	Marketing Margin on the Market Basket	"	"
32	Retail Cost of Dairy Products in the Market Basket	"	"
33	Marketing Margin on Dairy Products	"	"
34	Fluid Milk Marketing Margin	"	"
35	Butter Marketing Margin	"	"
36	American Cheese Marketing Margin	"	"

Table III. Variables Included in this Study, giving Description and Source of Data (Continued)

Variable Number	Description	Source
37	Evaporated Milk Marketing Margin	B.A.E., U.S.D.A
38	Estimated Population of the U.S.-	" "
39	Department Store Sales	Federal Reserve Bulletin
40	Milk, dry or powdered whole, average wholesale selling price per pound	B.A.E., U.S.D.A.
41	Dry Skim Milk, average wholesale price per pound	" "
42	Dried or Powdered Skim Milk, production	" "
43	Cheese, real wholesale price per pound at Chicago	#15 ÷ # 26
44	Cheese, real wholesale price on Wisconsin Cheese Exchange	16 ÷ 26
45	Creamery Butter, real wholesale price per pound	17 ÷ 26
46	Evaporated Milk, real wholesale price per case	18 ÷ 26
47	Delivered Milk, real retail price per quart	19 ÷ 25
48	Evaporated Milk, real retail price per 14½ oz. can	20 ÷ 25
49	Cheese, real retail price per pound	21 ÷ 25
50	Butter, real retail price per pound	22 ÷ 25

Table III. Variables Included in this Study, giving Description and Source of Data (Continued)

Variable Number	Description	Source
51	Oleomargarine, real retail price per pound	#23 : #25
52	Market Basket, real retail cost	30 : 25
53	Dairy Products in the Market Basket, real retail cost	32 : 25
54	Dry Whole Milk, real wholesale price per pound	40 : 26
55	Dry Skim Milk, real wholesale price per pound	41 : 26
56	Butterfat, real wholesale price per pound	9 : 26
57	Milk, real wholesale price per cwt. received by farmers	10 : 26
58	Real Purchasing Power in Manufacturing Industries	29 : 24
59	Manufacturing Industries Employment, advanced one month	#28 advanced one month
60	Manufacturing Industries Employment, advanced two months	28 advanced two months
61	Retail Food Price Index, advanced one month	25 " one "
62	Retail Food Price Index, advanced two months	25 " two "
63	Real Purchasing Power, advanced one month	58 " one "
64	Real Purchasing Power, advanced two months	58 " two "

Table III. Variables Included in this Study, giving Description and Source of Data (Continued)

Variable Number	Description	Source
65	Consumers Price Index, advanced one month	#24 advanced one month
66	Consumers Price Index, advanced two months	24 " two months
67-A	Time Variable, months	1,2,3,...,11,12
69-A	Time Variable, consecutive	1,2,3,....,156,....240
72	Time Variable, seasonal	
73	Creamery Butter, disappearance	B.A.E., U.S.D.A.
74	Cheese, factory made, whole milk and part skim, disappearance	" "
75	Evaporated Milk, disappearance	" "
76	Fluid Milk and Cream, disappearance	" "
77	Total Freight Car Loadings Index (1935-39 = 100)	Federal Reserve Bulletin
78	Short Term Consumers Debt	" " "
79	Industrial Production, Index of Physical Volume (1935-39 = 100)	" " "

In order to investigate the effects of one month's prices on a subsequent month's production or prices, four indicators are used. The Retail Food Price Index is advanced one month and thus compared with the other variables for the following month (for example, the Retail Food Price Index for January advanced and analyzed against February data) in #61; it is advanced two months and compared with the variables two months afterwards in #62. The general Consumers Price Index is advanced one month and compared with the variables in the following month in #65; it is advanced two months and compared with the variables two months afterwards in #66.

MARKETING MARGINS: The Retail Cost of the Market Basket and the Retail Cost of Dairy Products in the Market Basket comprise #30 and 32. (The Market Basket of Farm Food Products is a total of 93 food items, in proportions determined by the 1935-39 annual average purchases per family of three average consumers.) The marketing margins on the market basket, on dairy products as a whole, and on various individual dairy products comprise #31 and #33-37. (A marketing margin is defined by the B.A.E. as the difference between the retail price paid by consumers for a commodity and the payment to farmers for an equivalent amount of that commodity.)

DISAPPEARANCE DATA: The monthly disappearance of butter, cheese and evaporated milk appear as #73-75. The data for January, 1941 to February, 1947 have been approximated, since

the war years were not included in the regular published series. The approximations were made by using the annual disappearance data (which were available) for the individual products, and applying a monthly seasonal index for each which was derived from the monthly data of 1920-1940 and 1947-1949. The method of link relatives was used to derive these monthly seasonal indexes (3). These consumption data were for civilian consumption alone during the war years.

The monthly disappearance of fluid milk and cream, #76, was computed as a residual of the total monthly milk supply, after subtracting the milk equivalent of butter, cheese, evaporated milk and ice cream produced each month. This was necessary because the disappearance data for fluid milk and cream have not as yet been published. The four products listed above cover most of the dairy products consumed outside of fluid milk and cream and were the only ones available for use. The determination of the disappearance of fluid milk and cream by this residual method should approximate the actual disappearance relatively closely. A table showing the monthly disappearance of fluid milk and cream which was determined by this method is given in Appendix C.

There are no disappearance data shown for ice cream, since it is assumed that the production figures reproduce the disappearance figures closely. The milk equivalent for monthly ice cream production (used to derive the residual disappearance data of fluid milk and cream) was derived by taking the milk equivalent of the annual ice cream production

(which is available) and allocating it among the months by the amount of monthly ice cream production. This is not completely accurate, since some storage stocks of fluid cream are used for ice cream production during the off-season; however, it should be sufficiently accurate for use here.

GENERAL ECONOMIC INDICATORS: The Index of Employment for All Manufacturing Industries comprises variable #28. This is used as an indicator of total employment since the actual data for total U. S. employment is not available for a sufficient period of time. It has been assumed, however, that employment in manufacturing industries is a major element of total employment, and thus can be substituted for it. This employment variable is advanced one month in #59, to note the effect on other variables (i.e. January employment compared with February data); it is advanced two months in #60.

The Index of Payrolls in All Manufacturing Industries comprises #29. This is used as an indicator of national income. Actual national income statistics published on a monthly basis are adjusted for seasonal variation and it is almost impossible to derive the unadjusted data. This Index of Payrolls for manufacturing industries serves as an indicator of relative movement of the national income, rather than as an indicator of its absolute level. It omits such things as pensions, interest, and dividends; however, the series does provide comparable information on a relative basis even if somewhat understating the absolute levels.

An estimate of real purchasing power in manufacturing

industries (#58) was derived by dividing each month's payroll figure by the corresponding month's Consumer Price Index for All Commodities. This estimate of real purchasing power advanced one month is variable #63; it is advanced two months as #64.

The estimated population of the U. S. constitutes #38. Estimates have been made for the population at six months intervals, for January 1 and July 1, since 1909. These figures were adapted to monthly estimates by a straight line interpolation for each six months period. During the period 1941-1948, the estimates of the civilian population were used, rather than those of the total population, thus eliminating from the estimates the members of the armed forces. This estimate of the population is included as a separate variable, rather than taking account of it in the other variables (i.e. instead of using per capita production and consumption data the totals are used, and the population estimate included separately).

Total U. S. Department Store Sales are included as variable #39. Total freight car loadings comprise #77, short term consumers debt is #78, and the physical volume of industrial production is #79.

TIME VARIABLES: Three estimates of time trends have been included. A monthly time trend comprises #67-A (which in the original numbering of the variables included both 67 and 68); this was set up by a consecutive numbering of the

months from January to December. Thus a cyclical pattern is set up, which is repeated for each year. A consecutive, straight line trend comprises #69-A (which in the original numbering of the variables included 69, 70 and 71). This was to investigate any steady increase which exists in the included variables. A special seasonal trend comprises #72 ; this was set up to approximate the seasonal pattern of monthly milk production, in order to investigate its relationship with dairy products data.

Processing of Data

Since a factor analysis cannot begin until a table of intercorrelations is set up, the first step was to compute the simple correlations between each pair of variables for this table. With 76 independent variables in this study, there were 2,850 distinct correlations to be computed for each intercorrelation table and, since two different time periods were used, two intercorrelation tables were necessary. This made a total of 5,700 simple correlations to be computed. Each correlation in the first table contained 240 observations (the 240 months in the period 1929-1948), while each correlation in the second table contained 156 observations (the 156 months in the period 1929-1941).

Using the raw data for these computations would have involved very long and cumbersome processes. Using first differences between the observations, logarithms, or link relatives would have been just as cumbersome, if not more so.

Also, making all the necessary computations by hand calculating machines would have meant not only innumerable hours of labor but also innumerable possibilities of errors, due to the number of computations necessary.

In order to cut down on the number of computations and the possibilities of error, an I.B.M. tabulation set-up was used. Each variable was coded by taking the complete range of data and dividing it into equal parts, corresponding to the ten numerals (0,1,2,...,8,9) in each column of an I.B.M. card. Each variable was then assigned to a column of the I.B.M. card, i.e. variable #42 was also column 42 on the card. (The reason why some numbers were skipped in the numbering of the variables was due to this correspondence between the number of the variable and the number of the column on the I.B.M. card. The monthly seasonal time variable, #67-A, actually was placed in two columns, 67 and 68, since the seasonal was coded to correspond to the months, i.e. as 01,02,...10,11,12. The straight line trend, #69-A, actually covered three columns, 69, 70 and 71, to correspond to the consecutive numbering of the observations as 001,002,-...,011,012,013,...,239,240 for the first intercorrelation matrix and 001,002,...,011,012,013,...,155,156 for the second intercorrelation matrix. These numbers correspond to the total number of months in each time period. The variables #67-A and 69-A were the only ones to cover more than one column on the I.B.M. card; all the other variables were coded to include all the data in a single column.

Since the range of data usually differed for the two time periods under consideration, with higher values usually occurring in the period from 1941 to 1948 than had occurred during the period 1929-1941, two different codes were necessary for the two intercorrelation tables. For example, in variable # 7, Monthly Ice Cream Production, the range of values for the period 1929-1948 was from 5,631,000 gallons to 91,958,000 gallons per month. A large part of this increase occurred during the latter part of this period, however. During the period 1929-1941 the range of values was from 5,631,000 gallons to 54,681,000 gallons per month. The coding had to take into consideration this difference in the two time periods. The two complete codes for variable #7 are reproduced in full in Table IV.

Each variable was coded in this same fashion. Each code was different, depending on the range of values for the time period under consideration. The coding interval for each individual variable was kept constant, but this interval varied between variables and also varied for the same variable in the two correlation matrices due to the difference in the range of values. For example, in the code for "Ice Cream Production 1929-1948" (see Table IVa) the coding interval was 10,000,000 gallons, and this stayed constant for each code number. In the code for "Ice Cream Production 1929-1941" (Table IVb) the coding interval was 5,000,000 gallons and this stayed constant for each code number. However, the code interval obviously changed for

Table IV. Illustration of Coding Used for I.B.M. Process'

IVa. Ice Cream Production

Analysis I 1929-1948

Code Number	Interval (in thousands)
0	below 10,000 gallons
1	10,000 - 19,999 "
2	20,000 - 29,999 "
3	30,000 - 39,999 "
4	40,000 - 49,999 "
5	50,000 - 59,999 "
6	60,000 - 69,999 "
7	70,000 - 79,999 "
8	80,000 - up

IVb. Ice Cream Production

Analysis II 1929-1941

Code Number	Interval (in thousands)
0	below 10,000 gallons
1	10,000 - 14,999 "
2	15,000 - 19,999 "
3	20,000 - 24,999 "
4	25,000 - 29,999 "
5	30,000 - 34,999 "
6	35,000 - 39,999 "
7	40,000 - 44,999 "
8	45,000 - up

'Codes given are for Variable #7, Monthly Ice Cream Production

the same variable in the two time periods, and the code interval also changed between different variables since the range of values was different.

Each I.B.M. card contained the coded information for all variables for any given month. Thus the coded data for all variables for January, 1929 were on card #1, the data for February, 1929, on card #2, etc. By appropriately sorting and tabulating these cards, the sums, sums of squares, and cross-products for each variable were obtained. These were used to obtain the necessary correlations, which were computed by hand calculating machines rather than by I.B.M. machines. However, the use of the I.B.M. tabulations greatly reduced the number of hand computations and also reduced the number of possible errors in the calculations.

Comparison of Coded and Uncoded Data

It was recognized that coding the variables for the I.B.M. process might change the value of the correlation coefficients. A small number of variables were selected and correlations were computed for them using the uncoded data. Comparisons of the correlation coefficients derived from coded and uncoded data from both intercorrelation tables are given in Table V. These variables were selected at random from the complete correlation table.

The correlations for the coded data are generally lower than those for the uncoded data. Thus it can be said that

Table V. Comparison of Some Randomly Selected Correlation Coefficients showing Differences between Coded and Uncoded Data

A. Matrix I 1929-1948

Variables being Correlated	Correlation Coefficients Coded	Uncoded	Uncoded-Coded
1, 10	.1971	.2009	.0038
1, 25	.2379	.2605	.0226
1, 28	.3492	.3725	.0233
1, 29	.3414	.3744	.0330
25, 28	.7008	.7330	.0322
3, 12	-.1086	-.1030	.0056#
12, 19	.1586	.1834	.0248
19, 24	.9461	.9776	.0315
24, 28	.7141	.7178	.0037
28, 31	.4396	.4511	.0115
31, 39	.6398	.6873	.0475
39, 47	-.5813	-.5718	.0095#
47, 59	-.4861	-.4885	-.0024
59, 61	.6989	.7340	.0351
3, 61	.4765	.4957	.0192

B. Matrix II 1929-1941

1, 10	-.3029	-.3005	.0024#
1, 25	-.0862	-.0933	-.0071
1, 28	.0862	.1166	.0304
1, 29	.0918	.1326	.0408
25, 28	.4234	.4267	.0033
3, 12	-.1987	-.2159	-.0172
12, 19	.2055	.1965	-.0090#
19, 24	.8753	.8726	-.0027#
24, 28	.3009	.3044	.0035
28, 31	.0394	.0569	.0175
31, 39	.1013	.1106	.0093
39, 47	.1199	.1058	-.0141#
47, 59	.1564	.1100	-.0464#
59, 61	.3970	.4348	.0378
3, 61	-.1600	-.1266	.0334#

# Denotes poorer correlation coefficient in uncoded data than in coded data

the correlation coefficients for the coded data are in general underestimated rather than overestimated. These effects of the coding of the data might be reflected in the factor analysis but, if so, they would tend to underestimate the common factors and attribute more of the variation to unique factors. This underestimation of common factors is less serious than an overestimation of common factors.

Comparison of the Correlation Coefficients of the Two Time Periods

From Table V it can be seen that the correlation coefficients from Matrix I, 1929-1948, were generally higher than those concerning the same variables from Matrix II, 1929-1941. For example, the coded correlation between variables #25 and #28 was .7008 in Matrix I and .4234 in Matrix II. This was true for the majority of the coded correlation coefficients.

It can be seen how the correlation coefficients were lower during 1929-1941 than during 1929-1948 when the effects of the business cycle are considered in relation to these data. During 1929-1941 business conditions were in a very unsettled state, and the variables under consideration here were not all affected in the same fashion or at the same time by these business conditions. However, over the longer period of time, with the addition of the inflationary trends of the period 1941-1948 which affected practically all of these data in a like manner, the correlations between

variables for the period 1929-1948 were generally higher.

Even though this discrepancy exists between these two time periods, factor analyses can be applied to the individual time periods. As subsequent sections show, the same factors may be found existing in both time periods even though differences exist in the correlation coefficients.

Computation Methods Used in Factor Analyses

A multiple group centroid method of factorization was used in all analyses in this study. Thus several factors in any one analysis could be determined simultaneously. If the residual matrix showed many large values, the factorization process was continued until the residual matrix contained values which were not significant. Any value below 0.16 was judged to be non-significant. Any variables showing non-significant residuals were removed from the residual matrix before the factorization process was continued with the variables still showing significant residuals.

The communalities were estimated by selecting the highest coefficients appearing for the individual variables. These communalities were reestimated in the residual matrix before the factorization process was continued; this was done to increase the precision of the estimate of the communalities. However, in a few cases this reestimation of the communalities resulted in over-determination, as the total communality resulting from the factor structure was over 1.00. Some of

these cases have been mentioned in the text where they are an important part of the analysis. The complete number of variables whose communalities have been overestimated can be found in Appendix A, where the orthogonal structures and communalities for all variables in the individual analyses have been given.

An orthogonal structure was derived for each analysis. The axes were then rotated to obtain the best simple structure, and in most cases oblique, rather than orthogonal, structures resulted. The rotated factor structures, along with the cosines of the angles between the factors, have also been given in Appendix A. In a few cases distortions arose from the rotation process, where a variable which showed a fairly clear structure in the orthogonal matrix showed an indeterminate structure in the rotated matrix. In these cases both the orthogonal and the rotated matrices were used in the analysis of the factor structure. Most of these cases of distortions due to the rotation process have been noted in text wherever they were important in the analysis.

The absolute sizes of the factor loadings in the rotated matrices were not of major significance. The relative sizes of the factor loadings within each factor were of importance and the directions of the loadings, i.e. whether they were positive or negative, were also of importance. A comparison of the sizes of factor loadings between factors of different analyses or between factors within the same analysis would have little meaning, as the sizes of these loadings depended

upon the rotation process which differed between analyses.

Individual Factor Analyses

The 76 variables included in this study were not analyzed as a complete group. Instead, separate analyses were made of various groups of these variables. These groups included: General Economic Conditions; Prices; Fluid Milk and Cream; Butter; Cheese; Condensed, Dry and Evaporated Milk; Production and Disappearance of Dairy Products; Marketing Margins. Each variable was used at least once in these analyses.

Each group consisted of two analyses, one covering the period 1929-1948 and the other the period 1929-1941. A comparison was then made of these two analyses, discussing the similarities and differences which existed. For the individual commodities estimates of the monthly disappearance in 1949 and the first part of 1950 were made using multiple regression systems based on the factor analyses. These regression systems were set up using the same number of variables as there were factors in the commodity analysis and the variables for these systems were selected from the point clusters of the factors.

The analysis of General Economic Conditions included graphs of the factor structure to illustrate the point clusters and the factor configurations. The graphic structure has been omitted from all other analyses, however, since these structures become more cumbersome when more than two factors are present. Each analysis contains a summary of the factor

structure, giving those variables showing simple structure, those showing complex structure, and those showing an indeterminate structure in the analysis. The complete orthogonal matrices and rotated matrices with the cosines of the angular separations between the factors for all analyses will be found in Appendix A.

IV. ANALYSES OF ECONOMIC DATA

GENERAL ECONOMIC CONDITIONS

All of the variables included in this study which pertain to general economic conditions were included in this group. These included, among others, the consumers price index, the food price index, indices of employment and payrolls in manufacturing industries, real purchasing power, short term consumer debt, and industrial production. A complete list of these variables is given in Table VI. A discission of the factor analyses of these variables follows.

Analysis I 1929-1948

Two factors were evident among these variables. These factors were not independent; there was some relationship between them. A graphic presentation of the factor structure is given in Figure 8. A summary of this structure is given in Table VII. This latter table gives the variables where the principal component was Factor I or Factor II and the variables which were influenced by neither Factor I nor Factor II (denoted as Indeterminate in this structure).

The variables influenced by Factor I were wholesale and

retail prices, both actual and advanced through time, the estimated population, and short term debt. Almost all of these are consistent with the hypothesis that Factor I was an indicator of the general price level. The general price level factor had a great influence on the indexes of wholesale and retail prices and also on the amount of short term consumer debt. The appearance of the Estimated U. S. Population in this group was probably an accidental relationship. This will be discussed again later.

The variables influenced by Factor II were industrial employment, both actual and advanced through time, real purchasing power, both actual and advanced through time, and an index of industrial production. All of these are consistent with the hypothesis that Factor II was an indicator of general industrial activity.

Department Store Sales, #39, were primarily influenced by Factor I, the general price level factor, although Factor II, the industrial activity factor, appeared to have a slight influence on this variable also. Industrial Payrolls, #29, were mostly influenced by the industrial activity factor, although the general price level factor influenced them somewhat.

The Marketing Margin on the Market Basket, #31, appeared to be largely influenced by the general price level factor and somewhat adversely affected by the industrial activity factor. In other words, as industrial activity increased, marketing margins on the market basket decreased; as industrial

Table VI. Variables Used in Analysis of General Economic Conditions

	Variable No.	Description
1.	24	Consumers Price Index for Moderate Income Families in Large Cities
2.	25	Retail Food Price Index for Large Cities
3.	26	Index of Wholesale Food Prices
4.	27	Index of Wholesale Prices of All Commodities
5.	28	Employment Index for All Manufacturing Industries
6.	29	Payroll Index for All Manufacturing Industries
7.	30	Retail Cost of the Market Basket
8.	31	Marketing Margin on the Market Basket
9.	38	Estimated Population of the U. S.
10.	39	Department Store Sales
11.	52	Real Retail Cost of the Market Basket
12.	58	Real Purchasing Power in Manufacturing Industries
13.	59	Employment advanced 1 month
14.	60	Employment advanced 2 months
15.	61	Retail Food Prices advanced 1 month
16.	62	Retail Food Prices advanced 2 months
17.	63	Real Purchasing Power advanced 1 month
18.	64	Real Purchasing Power advanced 2 months
19.	65	Consumers Price Index advanced 1 month
20.	66	Consumers Price Index advanced 2 months
21.	67	Monthly Time Trend
22.	69	Consecutive Time Trend
23.	77	Index of Total Freight Car Loadings
24.	78	Short Term Consumer Debt
25.	79	Industrial Production (Index of Physical Volume)

Table VII. Summary of Factor Structure of General Economic Conditions

Analysis I 1929-1948 (2 factors)

Factor I

Variable No.	Factor Loading (Rotated Matrix)	Description
24	.726	Consumer Price Index in Large Cities
25	.741	Index of Retail Food Prices
26	.690	Wholesale Price Index for Foods
27	.658	Wholesale Price Index for All Commodities
30	.697	Retail Cost of the Market Basket
31	.886	Marketing Margin on Market Basket
38	.552	Estimated Population of the U. S.
39	.484	Department Store Sales
61	.755	Retail Food Prices advanced 1 month
62	.760	Retail Food Prices advanced 2 months
65	.733	Consumer Price Index advanced 1 month
66	.737	Consumer Price Index advanced 2 months
78	.641	Short Term Consumer Debt

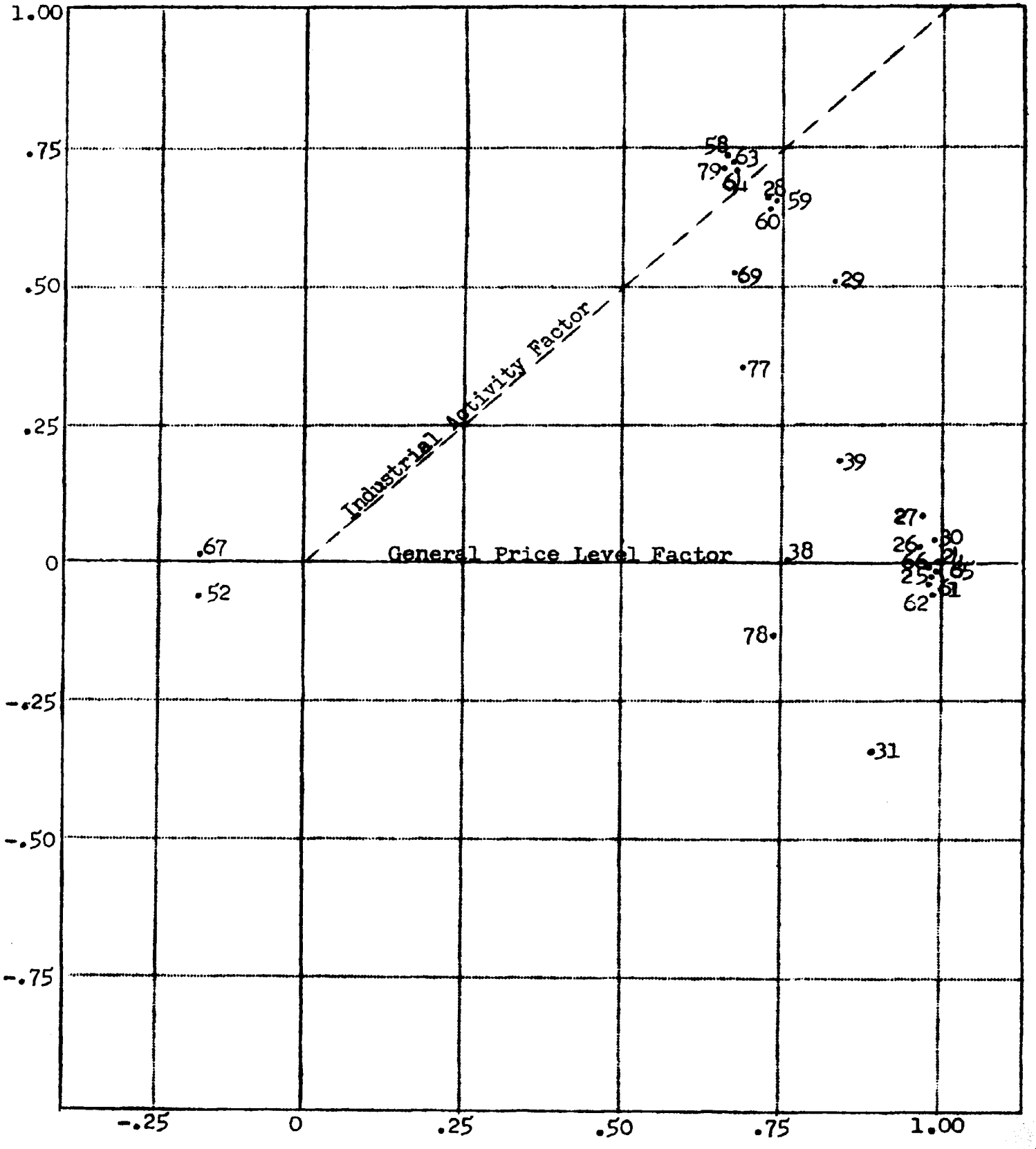
Factor II

28	.690	Index of Employment in All Manufacturing Industries
29	.543	Index of Payrolls in All Manufacturing Industries
58	.753	Real Purchasing Power in Manufacturing Industries
59	.686	Index of Employment advanced 1 month
60	.679	Index of Employment advanced 2 months
63	.747	Real Purchasing Power advanced 1 month
64	.738	Real Purchasing Power advanced 2 months
69	.545	Consecutive Time Trend
79	.743	Index of Industrial Production

Indeterminate

52		Real Retail Cost of the Market Basket
67		Monthly Time Variable
77		Index of Total Freight Car Loadings

Figure 8. Orthogonal Factor Structure of General Economic Conditions, Analysis I, 1929-1948.



activity decreased, marketing margins increased. This is consistent with the observation that marketing margins are 'sticky', and that they tend to respond slowly to economic changes. However, the high loading on Factor I shows they were mostly influenced by the general price level factor.

The Real Retail Cost of the Market Basket, #52, was not influenced by either Factor I or Factor II. With the effects of the price level removed from this variable, it should not have been affected by the general price level factor. This signifies that real retail food prices were not influenced by the level of industrial activity.

There was no evidence of a monthly seasonal pattern in either of these factors, as the monthly seasonal trend variable, #67, had insignificant factor loadings on both Factor I and Factor II.

The Index of Freight Car Loadings was about equally influenced by these two factors, although together they explained only about 60% of the variations in this variable. Since neither factor was predominant and the factor loadings of both were small in the rotated matrix, this variable has been classified as Indeterminate in structure.

In summary, two factors were determined in this analysis of indices of general economic conditions. These were a general price level factor and an industrial activity factor. These two factors explained over 80 percent of the variations in 18 out of the 25 variables included in this analysis.

Analysis II 1929-1941

Two distinct factors were evident in this analysis; however, these factors were not independent. A graphic presentation of the factor structure is given in Figure 9. A summary of this structure is given in Table VIII. The latter gives the variables where the principal component was Factor I or Factor II, the variables which were influenced by both I and II (hence denoted as Complex in structure) and the variables which were influenced by neither Factor I nor Factor II (denoted as Indeterminate in this structure).

The first factor contained indices of retail prices, and appears to be consistent with the hypothesis that Factor I was an indicator of the general price level. The Index of Retail Food Prices was influenced by this factor, as was this same variable advanced through time. The same holds true for the Consumer Price Index.

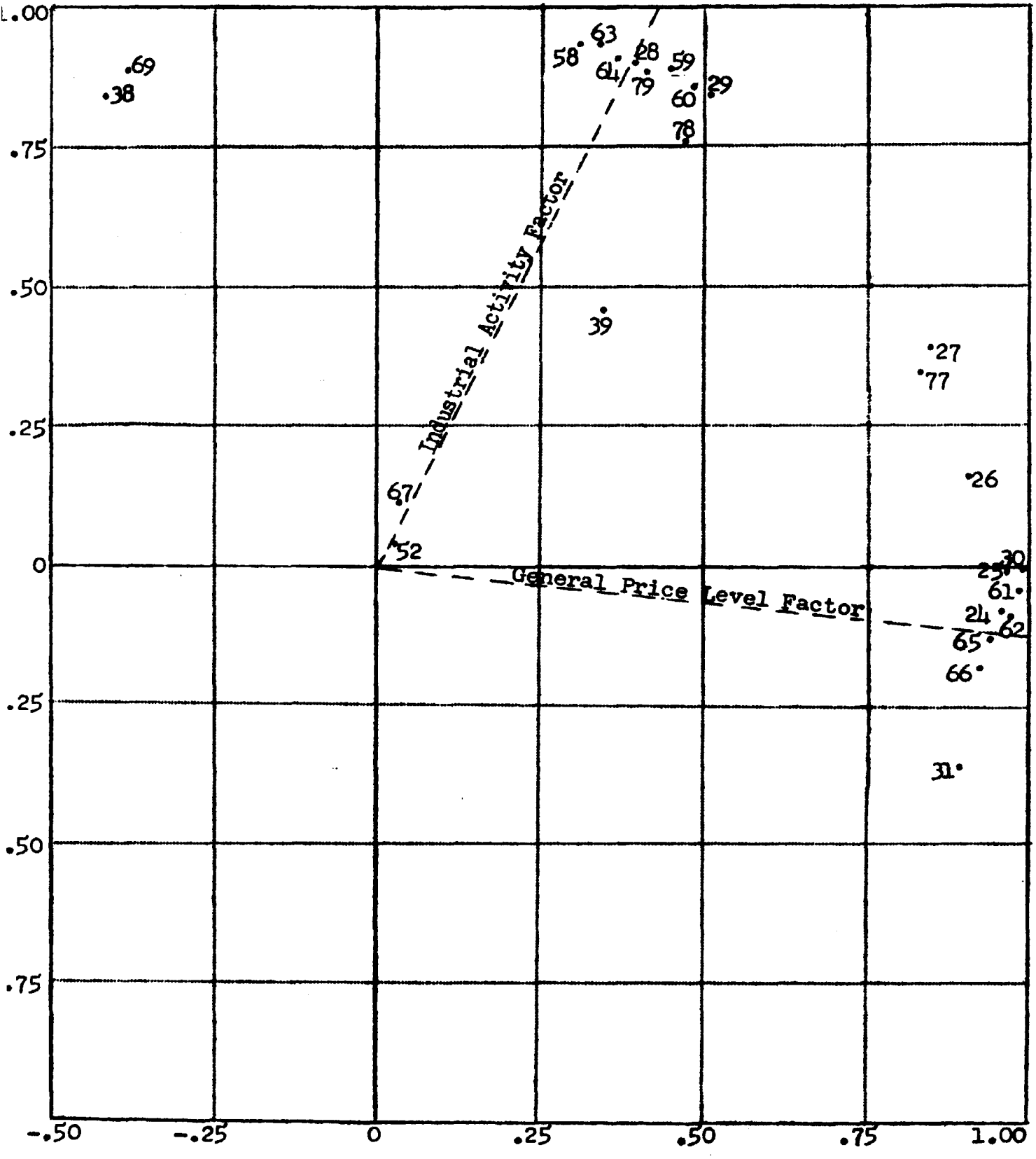
Factor II contained indexes of employment, payrolls, purchasing power, short term consumer debt, and industrial production. These are consistent with the hypothesis that Factor II was an indicator of industrial activity. Variable #78, Short Term Consumer Debt, was almost entirely influenced by Factor II, even though this factor explained a somewhat smaller proportion of the variance within this variable than it explained in the other variables in this cluster. Department Store Sales, #39, also seemed to be influenced solely by Factor II, even though this factor only explained a small part of the variation within this variable. This might be

Table VIII. Summary of Factor Structure of General Economic Conditions

Analysis II 1929-1941 (2 factors)

Variable No.	Factor Loading (Rotated Matrix)		Description
			Factor I
24	.909		Consumer Price Index in Large Cities
25	.895		Index of Retail Food Prices
26	.768		Wholesale Price Index for Foods
30	.896		Retail Cost of the Market Basket
31	.961		Marketing Margin on Market Basket
61	.916		Retail Food Prices advanced 1 month
62	.927		Retail Food Prices advanced 2 months
65	.912		Consumers Price Index advanced 1 month
66	.917		Consumers Price Index advanced 2 months
			Factor II
28	.927		Index of Employment in All Manufacturing Industries
29	.873		Index of Payrolls in All Manufacturing Industries
58	.964		Real Purchasing Power in Manufacturing Industries
39	.492		Department Store Sales
59	.915		Index of Employment advanced 1 month
60	.895		Index of Employment advanced 2 months
63	.955		Real Purchasing Power advanced 1 month
64	.938		Real Purchasing Power advanced 2 months
78	.797		Short Term Consumer Debt
79	.931		Index of Industrial Production
			Complex
27	(I) .628	(II).464	Wholesale Price Index for all Commodities
38	(I)-.706	(II).762	Estimated U. S. Population
69	(I)-.690	(II).816	Consecutive Time Variable
77	(I) .624	(II).415	Index of Total Freight Car Loadings
			Indeterminate
52			Real Retail Cost of the Market Basket
67			Monthly Time Trend

Figure 9. Orthogonal Factor Structure of General Economic Conditions, Analysis II, 1929-1951.



due in part to more violent cyclical fluctuations in Department Store Sales than those in the other variables, and also to more violent seasonal fluctuations in this variable.

The Index of Wholesale Food Prices, #26, appeared to be influenced primarily by Factor I, the general price level factor, with Factor II, the general industrial activity factor, having only a slight influence on it. The Wholesale Price Index for All Commodities, however, showed a decrease in the influence of the general price level factor and an increase in the influence of the industrial activity factor. Freight Car Loadings, #77, were affected by the two factors about the same as the Wholesale Price Index for All Commodities, #27. The effect of the general price level factor was slightly more important than the industrial activity factor in both #27 and #77.

The Marketing Margin on the Market Basket, #31, showed a strong influence by Factor I, the general price level factor, and a negative influence of Factor II, the industrial activity factor. This same result was obtained in Analysis I.

The similarity between the Estimated U. S. Population, #38, and the straight line time trend, #69, signifies that the population estimates increased linearly over this period. A comparison between this linear trend, #69, and the remaining variables shows that there was a positive relationship with Factor II and a negative relationship with Factor I. This signifies that, although there was a linear change evident in the industrial activity factor, the trend in the

general price level was essentially non - linear.

The Real Retail Cost of the Market Basket, #52, and the monthly seasonal trend, #67, were not affected by either of these two factors, and hence were considered Indeterminate in this structure.

In summary, two factors were determined in this analysis, a general price level factor and an industrial activity factor. These two explained over 80 percent of the variations in 21 out of the 25 variables included in this analysis.

Comparison of the Two Analyses

The two analyses discussed above produced two factors involving approximately the same variables. The factor structures (Figures 8 and 9) showed many similarities and a few sharp differences.

A closer relationship existed between a general price level factor and an industrial activity factor during the period 1929-1948 than during the shorter period 1929-1941. The two factors were relatively more independent of each other during the shorter period of time. This was probably due to the differences in cyclical variations which occurred during these periods. The cyclical effects of the depression during the period 1929-1941 affected both industrial activity and the general price level, but these factors were not affected simultaneously and did not react to these cyclical variations in exactly the same manner. Thus the relationship between the two factors was not very large. These same

cyclical variations were included in the period 1929-1948, but the variations occurring during 1941 to 1948 were also added. During this period conditions resulting from World War II caused increases in both industrial activity and the general price level simultaneously. The close relationship between these two during the period 1942-1948 helps to explain why the over-all relationship between the two factors increased from that existing during the period from 1929-1941 to that existing over the entire period 1929-1948.

Approximately the same variables determined the two factors in these two analyses. Variables # 24, 25, 30, 61, 62, 65, and 66 determined Factor I in both cases. In Analysis I the Wholesale Food Price Index, #26, and the Wholesale Price Index for All Commodities, #27, also fit into the point cluster of Factor I. However, in Analysis II these two variables showed signs of being influenced by both factors, rather than by one factor alone. Variable #26 appeared to be primarily influenced by Factor I and secondarily by Factor II, while this situation was exactly reversed for #27. Wholesale prices followed the same pattern as retail prices in Analysis I and showed no influence of industrial activity; during the shorter period existing in Analysis II industrial activity appeared to have some affect upon wholesale prices.

The Marketing Margin on the Market Basket, #31, retained its same position in relation to the other variables in both

analyses. Variables #52, the Real Retail Cost of the Market Basket, and #67 the monthly time trend, shifted their positions slightly in the factor structures of the two analyses, but still showed no effects at all of the two factors.

The Index of Payrolls in Manufacturing Industries, #29, appeared as part of the factor cluster in Analysis II, signifying that these payrolls depended primarily upon industrial activity in 1929-1941. However, #29 moved from the cluster of points in Analysis I, signifying that although industrial activity had a strong influence on payrolls in manufacturing industries in this longer period, the general price level also was of importance. This was probably due to the fact that during 1929-1941 there was less than full employment and payrolls depended on the amount of industrial activity. Once full employment was reached the general price level became of greater importance in the level of wages and payrolls.

Variable 38, Estimated U. S. Civilian Population, was located in two entirely different positions in the two factor structures. In Analysis I, it followed the same pattern as the general price level. In Analysis II it followed a pattern comparable to industrial activity and a pattern opposite to that of the general price level. The estimated U. S. Population did not follow either of these factors too closely during 1929-1941, since the population was constantly increasing during this time while cyclical fluctuations occurred in the other data. The civilian population decreased

somewhat from 1942-1945, due to the induction of civilians into the armed forces, but increased again in 1946 with the end of World War II and the demobilization of forces. The pattern of prices shows that they fluctuated during 1929-1934, increased during 1935-1941, remained fairly stable during 1942-1945 (due to price controls), and rose rapidly in 1946 when price controls were removed. Thus the pattern of civilian population and the pattern of prices were similar over the period 1929-1948. This might explain in part the location of variable 38 in the factor structure of Analysis I.

Department Store Sales, #39, showed the influence of industrial activity to be stronger than that of the general price level during the period 1929-1941, while the influence of the general price level appeared stronger over the longer period 1929-1948. This might be due to the fact that department store sales depended on the physical volume of goods sold and the dollar volume of sales. Thus during 1929-1941 the effect of the physical volume of goods sold was predominant, while during the entire period 1929-1948 the dollar volume, which depends on the price level, was of greater importance. However, both factors explained only a small part of the variations in either time period. The remaining variations might be due to a very pronounced seasonal pattern of sales which was unique in this variable.

The variable showing straight line time trend, #69, did

not retain the same relationship with the rest of the variables during the two time periods being discussed here. This was primarily due to the cyclical fluctuations which affected the economic data. This variable can be considered immaterial to the explanation of the other variables in the analysis of General Economic Conditions.

Freight Car Loadings, #77, retained approximately the same relationship with the rest of the variables during these two time periods. However, the general price level and industrial activity accounted for more of the variation in Freight Car Loadings during 1929-1941 than during 1929-1948. This was probably due to extraneous factors which occurred during the war years, such as the allocation of freight cars to military uses.

Short Term Consumer Debt, #78, showed a complete reversal between factors during the two time periods. During 1929-1941, industrial activity had a large effect on consumer debt, while the general price level showed almost no effect at all upon it. This result is plausible. However, over the entire period 1929-1948 it appears that the general price level had the most important influence while industrial activity had a slight negative effect on short term consumer debt. In general, the patterns of prices and consumers debt were similar over this period. The slight negative effect of industrial activity upon consumer debt might be due to the credit restrictions which were in effect during the war; at least the volume of consumer debt decreased from 1942-1945 while

industrial production increased greatly over this same period. This might explain the slight negative relationship between Short Term Consumer Debt and industrial activity.

In subsequent analyses it will be desirable to include these two factors of general economic conditions. It is sufficient to include just one variable from the point cluster which determines the factor as representative of the factor if that factor is the major component of the variable selected. In other words, in Analysis I any one variable from the point cluster of #24, 25, 26, 27, 30, 61, 62, 65, 66 could be selected as representative of Factor I, while any variable from the point cluster of #28, 58, 59, 60, 63, 64, 79 could be selected as representative of Factor II.

The selection of these representative variables has been made as follows: the purpose of including the factors comprising general economic conditions in other analyses is to investigate what effects they might have in these analyses. Since many important changes come about first in some series and are later reflected in others it is desirable to select variables advanced in time, to see how these general indices affect the specific commodity indices of a month or two later (these being the time lags included in this study). It is also desirable to select the same representative variables for the two time periods since the factors are approximately the same.

In Factor I both the Consumer Price Index for All Commodities and the Retail Food Price Index are found advanced

through time in both analyses. The Consumer Price Index for All Commodities can be considered as more indicative of the general price level than the Retail Food Price Index, and the Consumer Price Index advanced one month, #65, has been selected as the representative of this general price level factor.

In Factor II the Index of Real Purchasing Power is the only variable present advanced through time. It has been decided to select #64, Real Purchasing Power advanced two months, as representative of the industrial activity factor, since this variable appears to be nearest the center of the point cluster in both analyses.

Summary

Two similar factors were derived from the variables in the two analyses described above. These were a general price level factor and an industrial activity factor. These two factors explained a major part of the variations occurring in the variables included in the analysis of general economic conditions. For subsequent analyses the Consumer Price Index for All Commodities advanced one month, #65, will be used as representative of the general price level factor while Real Purchasing Power advanced two months, #64, will be used as representative of the industrial activity factor.

# # # # # # # # #

PRICES

All of the indexes of prices included in this study were included in this group. Among these were retail, wholesale, and real prices of butterfat, milk, cheese, butter, evaporated milk, dry skim and dry whole milk, and oleomargarine. Also included were the milk - feed and butterfat - feed ratios, marketing margins, and various time trends. The purpose of this analysis was to investigate whether there were any general patterns which prices followed, i.e. to determine how many factors were present within the many price series and related series included. Real Purchasing Power advanced two months, #64, and the Consumer Price Index advanced one month, #65, were also included as representative of the industrial activity factor and the general price level factor determined in the analysis on General Economic Conditions, to investigate how these factors influenced prices.

A complete list of the variables included in this group is given in Table IX.

Analysis I 1929-1948

There were three distinct factors in this analysis. A summary of the variables in relation to the factor structure is given in Table X. This table shows the variables influenced by more than one factor (i.e. of Complex structure) and those showing no significant influence of any factor (hence classified as Indeterminate in structure).

Table IX. Variables Used in Analysis of Prices

	Variable No.	Description
1.	9	Butterfat, Av. price per lb. received by farmers
2.	10	Milk, Av. wholesale price per 100 lb. received by farmers
3.	11	Butterfat - feed price ratio
4.	12	Milk - feed price ratio
5.	13	Milk - av. dealers buying price per cwt. for city distribution
6.	14	Milk - av. price per cwt. paid producers delivered at condenseries
7.	15	Cheese: Av. wholesale price per lb. at Chicago
8.	16	Cheese: Wholesale price on Wisc. Cheese Exchange
9.	17	Creamery Butter: Av. wholesale price per lb.
10.	18	Evaporated Milk: Av. wholesale selling price per case
11.	19	Milk, fresh, delivered: Av. retail price per qt. in leading cities
12.	20	Evaporated Milk: Av. retail price per 14½ oz. can in leading cities
13.	21	Cheese: Av. retail price per lb. in leading cities
14.	22	Butter: Av. retail price per lb. in leading cities
15.	23	Oleo, uncolored: Av. retail price per lb. in leading cities
16.	32	Retail cost of dairy products in market basket
17.	33	Margin on Dairy Products
18.	34	Fluid Milk Marketing Margin
19.	35	Butter Marketing Margin
20.	36	American Cheese Marketing Margin
21.	37	Evaporated Milk Marketing Margin
22.	40	Milk, dry or powdered whole: Av. wholesale selling price per lb.
23.	41	Dry skim milk: Av. wholesale price per lb.
24.	43	Cheese - real wholesale price per lb. at Chicago (Av. wholesale price at Chicago ÷ Wholesale prices of Foods)
25.	44	Cheese: real wholesale price on Wisconsin Exchange
26.	45	Butter: real wholesale price
27.	46	Evaporated milk: real wholesale price
28.	47	Real retail price of delivered milk
29.	48	Real retail price of evaporated milk

Table IX. Variables Used in Analysis of Prices
(Continued)

	Variable No.	Description
30.	49	Real retail price of cheese
31.	50	Real retail price of butter
32.	51	Real retail price of oleo
33.	53	Real retail cost of dairy products in the Market Basket
34.	54	Real wholesale price of dry whole milk
35.	55	Real wholesale price of dry skim milk
36.	56	Real wholesale price of butterfat
37.	57	Real wholesale price of milk
38.	64	Real purchasing power advanced two months
39.	65	Consumer price index advanced one month
40.	67	Monthly time trend
41.	69	Consecutive time trend
42.	72	Seasonal milk production trend

Table X. Summary of Factor Structure of Prices

Analysis I 1929-1948 (3 factors)

Factor I

Variable No.	Factor Loading (Rotated Matrix)	Description
9	.505	Butterfat, Av. price per lb. received by farmers
10	.474	Milk: Av. wholesale price per cwt. received by farmers
13	.688	Milk: Av. dealers buying price per cwt. for city distribution
14	.673	Milk: Av. price per cwt. at condenseries
15	.679	Cheese: Av. wholesale price at Chicago
16	.665	Cheese: Wholesale price on Wisc. Cheese Exchange
17	.675	Butter: Av. wholesale price per lb.
18	.686	Evaporated Milk: Av. wholesale price per case
19	.670	Milk, delivered: Av. retail price in leading cities
20	.694	Evaporated Milk: Av. retail price per can
21	.679	Cheese: Av. retail price per lb.
22	.638	Butter: Av. retail price per lb.
23	.815	Oleomargarine: Av. retail price per lb.
32	.685	Retail Cost of Dairy Products in Market Basket
33	.670	Margin on Dairy Products
34	.650	Fluid Milk Marketing Margin
40	.502	Milk, dry or powdered whole: Av. wholesale selling price
46	-.502	Real wholesale price of Evaporated Milk
47	-.537	Real Retail price of Delivered Milk
50	.516	Real Retail price of Butter
51	.575	Real Retail price of Oleomargarine
65	.674	Consumers Price Index advanced one month

Table X. Summary of Factor Structure of Prices (Continued)

Analysis I 1929-1948 (3 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
		Factor II
11	.854	Butterfat - feed price ratio
12	.796	Milk - feed price ratio
72	-.491	Seasonal Milk Production Trend
		Factor III
41	.497	Dry Skim Milk: Av. wholesale price per lb.
54	.603	Real Wholesale price of dry whole milk
55	.745	Real Wholesale price of dry skim milk
56	.559	Real Wholesale price of butterfat
57	.619	Real Wholesale price of milk
64	.571	Real purchasing power advanced 2 months
		Complex
35	(I).936 (III)-.696	Butter Marketing Margin
36	(I).833 (III)-.473	American Cheese Marketing Margin
37	(I).707 (III)-.376	Evaporated Milk Marketing Margin
49	(I).751 (III)-.521	Real Retail Price of Cheese

Table X. Summary of Factor Structure of Prices (Continued)

Analysis I 1929-1948 (3 factors)

Indeterminate

Variable No.	Factor Loading (Rotated Matrix)	Description
43		Cheese: Real wholesale price per lb. at Chicago
44		Cheese: Real wholesale price on Wisc. Cheese Exchange
45		Butter: Real wholesale price
48		Evaporated Milk: Real retail price
53		Real Retail Cost of Dairy Products in Market Basket
67		Monthly Seasonal Variable
69		Consecutive Time Variable

The first factor was the general price level factor determined in the analysis of General Economic Conditions. This was evidenced by the presence of #65, the Consumer Price Index advanced one month, which represented the general price level factor in this analysis. The variables influenced by this factor were mainly wholesale and retail prices of individual products. The retail cost of dairy products in the market basket was also influenced primarily by this factor. The Marketing Margin on Dairy Products and the Marketing Margin on Fluid Milk appeared to be influenced solely by Factor I, although the other marketing margins showed a complex structure. This signifies that the marketing margin on dairy products was heavily weighted by the marketing margin on fluid milk rather than by the margins on the other dairy products.

The Real Retail Price of Butter, #50, and the Real Retail Price of Oleomargarine, #51, were the only real prices influenced positively by this general price level factor. This signifies that these real prices, with the effects of the price level removed from them, still followed a pattern similar to the general price level. Thus it appears that the price of butter and the price of oleo responded in a kind of geometric fashion to changes in the general price level over a long period of time. For example, if the general price level were to double, the prices of butter and oleomargarine would increase by approximately four times. However, the relatively small factor loadings indicate that other,

perhaps unique, factors would also have to be considered before the net change could be predicted.

The Real Wholesale Price of Evaporated Milk, #46, and the Real Retail Price of Delivered Milk, #47, had negative factor loadings on Factor I in the rotated matrix. These two were the only variables which showed negative loadings for this factor. The negative loadings indicate that the real prices of delivered milk and of wholesale evaporated milk decreased as the general price level increased.

Factor II was composed of three variables: the Butterfat - Feed Price Ratio, the Milk - Feed Price Ratio, and the trend of seasonal milk production. This factor was almost independent of the other two factors.

The Butterfat - Feed Price Ratio shows the amount of feed you can buy with one pound of butterfat; the Milk - Feed Price Ratio shows the amount of feed you can buy with one pound of milk. All of these are based on the current prices prevailing for the individual products. The general price level would affect the individual prices for these products but, assuming that the general price level affects them all in approximately the same manner, taking the ratio of the two prices would cancel out this effect. Since the quantity of milk produced over short periods of time is relatively constant, this factor appears to be a Feed Factor, reflecting the demand for and supplies of feed. The fact that the seasonal milk production trend had a negative loading on this factor indicates that this demand for feed was

contra - seasonal to the milk production trend. This may be explained by the fact that the peak in milk production occurs during the early summer when natural feed and pasture are readily available; the demand for feed is highest during the winter months when seasonal milk production is low. This inverse relationship is not exact, however, as some feed is used constantly over the year. This is shown by the factor structure also, since the negative loading for the seasonal milk production variable was only -.491. If this contra - seasonal tendency were very pronounced, this negative loading would have been much larger.

Factor III contained variable #64, Real Purchasing Power advanced two months, which represented the industrial activity factor determined in the analysis of General Economic Conditions. Thus Factor III could be considered an indicator of industrial activity. It is interesting that the real wholesale prices of dry whole milk, dry skim milk, butterfat, and milk (an average price for all milk sold by farmers) were influenced principally by this one factor. The wholesale price of dry skim milk (the others are real wholesale prices) was also influenced by this factor, although to a lesser extent than the others listed above.

Several variables had a complex factor structure. The Butter Marketing Margin, the American Cheese Marketing Margin and the Evaporated Milk Marketing Margin all had positive factor loadings on Factor I, the general price level factor,

and negative factor loadings on Factor III, the industrial activity factor. This indicates the 'stickiness' of marketing margins, which moved in general in the same direction as the price level but opposite in direction to industrial activity. In other words, if the general price level were to increase while industrial activity remained constant, marketing margins would increase. If industrial activity were to decrease while the general price level remained constant, marketing margins would increase. (A situation similar to this latter case occurred during the 1930's). If both the general price level and industrial activity were to change simultaneously, the net effects would depend on both the sizes and directions of change.

The Real Retail Price of Cheese, #49, also had a complex structure with a positive loading on Factor I and a negative loading on factor III. Although the actual price of cheese was influenced principally by the general price level factor, when this price level factor was removed it appears that the series still followed the same pattern as the general price level and a pattern opposite to that of industrial activity. Thus it seems that the price of cheese was affected geometrically by changes in the general price level and in an inverse ratio to changes in industrial activity.

Several variables were of indeterminate structure in this analysis. The real wholesale price of cheese, both at Chicago and on the Wisconsin Cheese Exchange, the real whole-

sale price of butter, the real retail price of evaporated milk, and the real retail cost of dairy products in the market basket all showed insignificant loadings in the rotated factor matrix. Of these, the real wholesale price of cheese was best explained as a combination of the three factors derived here, as about 70 percent of the variations in this real wholesale price (both at Chicago and on the Wisconsin Cheese Exchange) could be explained by these factors. The other variables mentioned above had a much lower percentage of their variations explained by these factors. It is significant, however, that these did not form a separate factor which would signify a similarity in their variations. Each must have had a unique form of variation.

There was no monthly seasonal trend or consecutive time trend evident in the price series included in this analysis, as these two variables both showed an indeterminate structure.

In summary, there were three factors evident in this analysis of prices. One was a general price level factor, the second was a feed factor which is important to only two variables and insignificant to the remainder, and the third was an industrial activity factor. These three factors accounted for over 80 percent of the variations in 25 out of the 42 variables included in this group.

Analysis II 1929-1941

There were five factors determined in this analysis. A summary of the factor structure is given in Table XI. There were no variables which showed a simple structure for Factor IV, and only one variable showed a simple structure for Factor V. These will be discussed later in this analysis.

Factor I contained the variables of wholesale and retail prices of individual dairy products and also the consumer price index advanced one month. This latter variable represented the general price level factor in this analysis. The other variables in this factor cluster are consistent with the hypothesis that Factor I was the general price level factor determined in the analysis of General Economic Conditions. It is interesting that the marketing margin on dairy products and the butter marketing margin followed the same trend as the general price level during this period. Various real prices, such as the real wholesale and real retail prices of butter, the real retail price of oleomargarine and the real wholesale price of butterfat also were a part of the factor cluster of Factor I. This indicates that the general price level had a multiple effect on these prices. However, the sizes of the factor loadings for these variables indicates that other factors would have to be considered since these variables were not influenced solely by the general price level factor.

Factor II contained the variables of the butterfat-feed price ratio, the milk-feed price ratio, and the seasonal milk production trend. This factor corresponded very closely to Factor II in Analysis I of Prices. Thus is was possible to consider this factor the feed factor which was determined in Analysis I.

Factor III contained the variables of the real wholesale price of cheese, the real retail cost of dairy products in the market basket, and the real wholesale price of dry skim milk. This might have been a real dairy price factor. Factor V appears to have been a real dairy price factor also; the factor structure indicates that there is a relatively strong relationship between the Factor III and Factor V.

The variable of Real Purchasing Power advanced two months, #64, had loadings on both Factor III and Factor IV. This indicates that the industrial activity factor (represented by this variable) had some effect on Factor III, the real dairy price factor, and also on Factor IV. The factor structure did not show the industrial activity factor as an independent factor in this analysis, however.

Actually, the factor structure for Factors III, IV, and V was not too well defined. Although Factor IV was a distinct factor in this analysis which was relatively independent of the other factors, there was no variable which showed simple structure for Factor IV. The close relationship between

Table XI. Summary of Factor Structure of Prices

Analysis II 1929-1941 (5 factors)

Factor I

Variable No.	Factor Loading (Rotated Matrix)	Description
9	.783	Butterfat: Av. price per pound received by farmers
10	.791	Milk: Average wholesale price per 100 pounds received by farmers
13	.877	Milk: Average dealers buying price for city distribution
14	.777	Milk: Average price per cwt. at condenseries
15	.707	Cheese: Av. wholesale price per lb. at Chicago
16	.733	Cheese: Wholesale price on Wisconsin Cheese Exchange
17	.796	Butter: Av. wholesale price per pound
18	.875	Evaporated Milk: Av. wholesale selling price per case
19	.832	Milk, delivered: Av. retail price per quart in leading cities
20	.961	Evaporated Milk: Av. retail price per 14½ oz. can
21	.970	Cheese: Av. retail price per pound
22	.849	Butter: Av. retail price per pound
23	.922	Oleomargarine: Av. retail price per pound
32	.905	Retail Cost of Dairy Products in the Market Basket
33	.936	Marketing Margin on Dairy Products in the Market Basket
35	.836	Butter Marketing Margin
40	.922	Milk, dry or powdered whole: Av. wholesale selling price per pound
41	.538	Dry skim milk: Av. wholesale price per pound
45	.452	Real wholesale price of Creamery Butter
50	.463	Real retail price of butter
51	.661	Real retail price of oleomargarine
56	.554	Real wholesale price of butterfat
65	.933	Consumer price index advanced one month

Table XI. Summary of Factor Structure of Prices
(Continued)

Analysis II 1929-1941 (5 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
		Factor II
11	.824	Butterfat-feed price ratio
12	.866	Milk-feed price ratio
72	-.490	Seasonal Milk Production Trend
		Factor III
43	.582	Cheese: real wholesale price per lb. at Chicago
44	.555	Cheese: real wholesale price on Wisconsin Cheese Exchange
53	.736	Real retail cost of dairy products in the Market Basket
55	.701	Real wholesale price of dry skim milk
		Factor V
48	.707	Real retail price of evaporated milk
		Complex
34	(I) .584 (IV) .615	Fluid Milk Marketing Margin
36	(I) .728 (III)-.500	American Cheese Marketing Margin
37	(I) .652 (III)-.506	Evaporated Milk Marketing Margin
46	(III).519 (IV) .448 (V) .675	Real wholesale price of evaporated milk
47	(I)-.593 (III) .492 (IV) .585	Real retail price of delivered milk
49	(I) .645 (V) .468	Real retail price of cheese

Table XI. Summary of Factor Structure of Prices
(Continued)

Analysis II 1929-1941 (5 factors)

Complex

Variable No.	Factor Loading (Rotated Matrix)				Description
54	(I)	.532	(V)	.613	Real wholesale price of dry whole milk
57	(I)	.417	(III)	.432	Real wholesale price of milk
64	(III)	.452	(IV)	.538	Real purchasing power advanced two months
69	(I)	-.459	(III)	.530	Consecutive Time Trend
			(IV)	.585	

Indeterminate

45	Real wholesale price of creamery butter
67	Monthly Time Trend

Factor III and Factor V indicates that they might have been one factor which was over-determined in this analysis. Another possibility is that the unsettled conditions of the depression years caused erratic changes in these variables rather than uniform changes. If they had all reacted in a similar fashion to conditions over this period a more definite structure would probably have been obtained.

Several variables showed a complex structure in this analysis. The number and the complexity of these variables are another indication of the indeterminate nature of the factor structure.

In summary, there were five factors determined in this analysis. The first two factors, the general price level factor and the feed factor, were fairly well determined. The other three factors were not well determined and there was not enough information in the factor structure to identify them satisfactorily. The complete factor structure explained over 80 percent of the variations in 31 out of the 42 variables included in this group.

Comparison of Analyses

There were three factors determined in Analysis I and five factors determined in Analysis II. Two factors were the same in these two analysis; a general price level factor and a feed factor were fairly well determined in both analyses. An industrial activity factor was determined in

Analysis I; however, although there were indications that this factor was a part of two of the other factors determined in Analysis II, the industrial activity factor did not appear as a separate factor in Analysis II. Aside from the general price level factor and feed factor mentioned above, Analysis II showed an indeterminate structure and a satisfactory explanation for three out of the five factors determined in Analysis II could not be given.

The factor structures of Analysis I and Analysis II showed that the general price level factor involved both wholesale and retail prices; thus in general wholesale and retail prices followed the same general trend. The feed factor which was determined in both Analysis I and Analysis II was relatively independent of the other factors in both analyses. This indicated that the feed factor had little or no influence on the prices included in this group. The industrial activity factor determined in Analysis I involved variables of real wholesale prices, showing that these real wholesale prices followed the same trend as industrial activity and real purchasing power during the period 1929-1948. This factor was not evident during the period 1929-1941, probably as a result of the unsettled economic conditions existing during that time.

Although the factor structure of Analysis II was largely indeterminate, a few general observations may be made from the factor structure of Analysis I. During the period covered by Analysis I, 1929-1948, marketing margins on fluid milk followed the trend of the general price level. Marketing

margins on dairy products in the market basket also followed the trend of the general price level, signifying that fluid milk had the largest influence in the combined group of dairy products. Other dairy products, such as butter, cheese, and evaporated milk, showed that they followed the trend of the general price level but were inverse to the trend of industrial activity. In other words, if the general price level were to rise, the marketing margins on butter, cheese, and evaporated milk would rise. If industrial activity were to rise, the marketing margins on these products would fall. Both of these reactions assume that all other factors remained the same. If both the general price level and industrial activity were to change, the net effect of these changes would have to be considered.

During this period the real retail price of delivered milk and the real wholesale price of evaporated milk were opposite to the trend of the general price level. Thus as the general price level increased the real retail price of delivered milk and the real wholesale price of evaporated milk went down, while as the general price level decreased these real prices went up. This indicated that the prices of delivered milk and evaporated milk were not as flexible as the general price level during 1929-1948.

Since the feed factor was relatively independent of the other factors in the analyses discussed above, the butterfat-feed price ratio and the milk-feed price ratio (the variables which determined the feed factor) showed no relationship with

the price variables included in this group.

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FLUID MILK AND CREAM

All of the variables pertaining to fluid milk in this study were included in this group. Also included were variables which were used as a part of the pricing formulas in federal milk marketing orders, such as Department Store Sales and prices for dry and powdered skim and whole milk. Three time trends were included, and so was the Index of Payrolls in Manufacturing Industries. A complete list of the variables used in this group is given in Table XII.

Analysis I 1929-1948

Although there were just three distinct factors in this analysis, the factor structure indicated that there were actually four factors present. A summary of the factor structure is given in Table XIII.

The variables contained in Factor I and the sizes of the factor loadings indicate that two factors were present in Factor I. These were the two factors of General Economic Conditions, the general price level factor and the industrial activity factor. This is shown by the fact that price variables from the general price level factor cluster were contained in Factor I in addition to the payroll and department store sales variables which were a part of the industrial activity factor cluster. The factor loadings were also

similar to those in the General Economic Conditions analysis. Thus the first two factors in this analysis were a general price level factor and an industrial activity factor.

Factor III contained the variables of milk production on farms, the seasonal milk production trend, and the monthly disappearance of fluid milk and cream. This factor was probably a production factor. The sizes of the factor loadings indicate that the seasonal milk production trend variable followed the actual milk production and also that the disappearance of fluid milk and cream followed a similar pattern to the production pattern.

Factor IV contained the variables of the real wholesale price of milk and the real wholesale price of dry skim milk. This indicates that these two followed approximately the same pattern. This factor might be called a real wholesale dry skim milk price factor.

Two variables had a complex structure in this analysis. The milk-feed price ratio showed a positive loading on Factor III, the milk production factor and a positive loading on Factor IV, the real wholesale dry skim milk price factor. The positive loading on Factor III was opposite in direction to the other variables in this factor, indicating that the milk-feed price ratio had an inverse relation to milk production; the positive loading on Factor IV indicates that it had a direct relationsnip with the real wholesale dry skim milk price. The Average Wholesale Price of Dry Skim Milk, #41, had

Table XII. Variables Used in Analysis of Fluid Milk

	Variable No.	Description
1.	1	Milk Production on Farms
2.	10	Milk: Av. wholesale price per 100 lb. received by farmers
3.	12	Milk - feed Price Ratio
4.	13	Milk: Av. dealer buying price for city distribution
5.	19	Milk: Av. retail price per quart
6.	25	Retail Food Prices in Large Cities
7.	29	All Manufacturing Industries - Payroll
8.	32	Retail Cost of Dairy Products
9.	33	Margin on Dairy Products
10.	34	Fluid Milk Marketing Margin
11.	39	Department Store Sales
12.	40	Milk: Dry or powdered whole: Av. wholesale selling price per lb.
13.	41	Dry Skim Milk: Av. wholesale price per lb.
14.	47	Real Retail Price of Delivered Milk
15.	55	Real Wholesale Price of Dry Skim Milk
16.	57	Real Wholesale Price of Milk
17.	67	Monthly Time Trend
18.	69	Consecutive Time Trend
19.	72	Seasonal Milk Production Trend
20.	76	Monthly Disappearance of Fluid Milk and Cream

Table XIII. Summary of Factor Structure of Fluid Milk

Analysis I 1929-1948 (4 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
	Factor I, II	
10	.828	Milk: Av. wholesale price per 100 lb. received by farmers
13	.939	Milk: Av. dealers buying price per cwt. for city distribution
19.	.923	Milk: Fresh delivered; av. retail price per qt. in cities
25	.925	Retail Food Prices in Large Cities
29	.725	Payrolls in Manufacturing Industries
32	.934	Retail Cost of Dairy Products in Market Basket
33	.918	Margin on Dairy Products
34	.900	Fluid Milk Marketing Margin
39	.777	Department Store Sales
40	.848	Milk: dry or powdered whole; Av. wholesale selling price per lb
47	-.750	Real Retail Price of Delivered Milk
69	.595	Consecutive Time Trend
	Factor III	
1	-.866	Milk, Production on Farms
72	-.831	Seasonal Milk Production Trend
76	-.780	Monthly Disappearance of Fluid Milk and Cream
	Factor IV	
55	.792	Real Wholesale Price of Dry Skim Milk
57	.754	Real Wholesale Price of Milk
	Complex Structure	
12	(III) .437 (IV) .570	Milk - feed Price Ratio
41	(I) .579 (IV) .606	Dry Skim Milk: Av. wholesale price per lb.
	Indeterminate	
67		Monthly Time Trend

a positive loading on Factor I and Factor IV. The analysis of prices indicates that the positive loading of Factor I was a positive effect of the general price level factor. The positive loading on Factor IV shows that the wholesale price of dry skim milk was influenced by the real wholesale price of dry skim milk and this result is consistent.

The monthly seasonal trend had an indeterminate structure in this analysis, showing very little influence of any of these factors.

In summary, there were actually four factors determined in this analysis: a general price level factor, an industrial activity factor, a milk production factor, and a real wholesale dry skim milk price factor. These factors accounted for over 80 percent of the variations in 13 out of the 20 variables in this group.

Estimation of Fluid Milk and Cream Disappearance

One variable was selected to represent each of the above factors in the regression system on the disappearance of fluid milk and cream. The Consumer Price Index advanced one month, #65, was used to represent the general price level factor even though this variable was not included in this analysis, since it was used uniformly to represent the general price level factor wherever possible in this study. The variable of Real Purchasing Power advanced two months, #64, was selected to represent the industrial activity factor for the same reason. Milk Production on Farms, #1, was selected to represent the

milk production factor, and the Real Wholesale Price of Milk, #57, was used to represent the real wholesale dry skim milk price factor. All of these variables were used as independent variables in this regression system with Fluid Milk and Cream Disappearance, #76, as the dependent variable.

The coefficient of multiple regression between these variables was r = .8642. The coefficient of determination was r^2 = .7468. This indicates that approximately 75 percent of the variation in fluid milk and cream disappearance was explained by these four factors. Also, the coefficients of all of these variables were significant to the analysis.

A second regression system was set up with fluid milk and cream disappearance as the dependent variable and the consumer price index advanced one month, real purchasing power advanced two months, and the real wholesale price of milk as independent variables. This system investigated how much influence these variables had on the disappearance of fluid milk and cream when the production factor was eliminated. It yielded a coefficient of multiple regression of r = .5783 and a coefficient of determination of r^2 = .3345. This signifies that these three variables, two of general economic conditions and the third of the real wholesale price of milk, explained approximately 33 percent of the variation in the disappearance of fluid milk and cream. Thus the addition of the production factor to this system explained an additional 42 percent of the variation in disappearance, since the complete system of four variables explained 75 percent of

these variations.

A third regression system was set up using the Retail Price for Delivered Milk, #19, as the representative of Factor I, with Milk Production on Farms, #1, Real Wholesale Price of Milk, #57, and Real Purchasing Power advanced two months, #64, as the other independent variables and Fluid Milk and Cream Disappearance, #76, as the dependent variable. Hence this system was similar to the first system described above, with the retail price of milk replacing the consumer price index advanced one month as the representative of Factor I, the general price level factor.

The coefficient of multiple regression in the latter system was $r = .8412$. The coefficient of determination was $r^2 = .7076$. These results were very similar to the first regression system, where the coefficient of multiple correlation was $r = .8642$ and the coefficient of determination was $r^2 = .7468$. Thus it appears that these two systems provided essentially the same results, and that the substitution of one variable for another (where the two variables were from the same factor cluster) made no difference in the coefficient of multiple correlation. The substitution of the retail milk price for the consumer price index in the regression system made very little difference in the regression coefficient.

However, it should be noted in these systems that the simple correlation between total milk production and fluid milk and cream disappearance was $r = .7890$ and the coefficient of determination was $r^2 = .6225$. The large degree of corre-

spondence between these two variables might be due to the fact that fluid milk and cream disappearance was computed as a residual after the milk equivalents of several manufactured dairy products were deducted from total milk production. A more precise measurement of disappearance would probably make the above regression systems more meaningful.

The regression systems discussed above will be found in detail in Appendix B.

Analysis II 1929-1941

There were six factors derived from this analysis. A summary of the factor structure is given in Table XIV.

Factor I appeared to be the general price level factor discussed earlier in this study. The variables included in this factor were average dealers buying price for milk, retail food price index, retail cost of dairy products in the market basket, marketing margin on dairy products, and average wholesale selling price for dry or powdered whole milk. These variables were all found in the general price level factor in either the analysis of General Economic Conditions or the analysis of Prices.

Factor II contained the variables of seasonal milk production trend and the disappearance of fluid milk and cream. The variable showing milk production on farms had a complex structure with this factor and Factor IV, but from the composition of the factor cluster, it can be assumed that Factor II was a milk production factor.

Factor III contained only one variable showing simple structure. This variable was #29, the Index of Payrolls in Manufacturing Industries. Since this variable was found in the cluster denoting the industrial activity factor in the analysis of General Economic Conditions, this factor might be assumed to be the same industrial activity factor.

Factor IV contained only one variable with simple structure. This was variable #19, the Average Retail Price of Delivered Milk. It is interesting that this factor was relatively independent of all others in this analysis. This factor could be considered a retail milk price factor which was unaffected by the other factors.

Factor V contained the variables of department store sales and the monthly seasonal time trend. This illustrates that department store sales had a pronounced seasonal trend which was not shared by the other variables in this analysis. Since this seasonal trend factor had a minor relationship with the other factors, it was considered to be immaterial to this analysis.

Factor VI contained only one variable with simple structure. This was variable #55, the Real Wholesale Price of Dry Skim Milk. This factor might be termed a real wholesale dry skim milk factor; it was relatively independent of all other factors in this analysis with the exception of Factor III, the industrial activity factor. However, even this relationship between Factor III and Factor VI was minor.

Table XIV. Summary of Factor Structure of Fluid Milk

Analysis II 1929-1941 (6 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
		Factor I
13	.644	Milk: Av. dealers buying price for city distribution
25	.788	Retail Food Prices in Large Cities
32	.657	Retail Cost of Dairy Products in Market Basket
33	.734	Margin on Dairy Products
40	.615	Milk, dry or powdered whole: Av. wholesale selling price per lb
		Factor II
72	-.693	Seasonal Milk Production Trend
76	-.753	Disappearance of Fluid Milk and Cream
		Factor III
29	.619	All Mfg. Industries - Payroll
		Factor IV
19	-.570	Milk, fresh, delivered: Av. retail price per qt. in leading cities
		Factor V
39	.661	Department Store Sales
67	.629	Monthly Time Trend
		Factor VI
55	.685	Real Wholesale Price of Dry Skim Milk

Table XIV, Summary of Factor Structure of Fluid Milk (Continued)

Analysis II 1929-1941 (6 factors)

Variable No.	Factor Loading (Rotated Matrix)		Description
			Complex
1	(II)-.813	(IV).553	Milk, Production on Farms
41	(I) .513	(VI).687	Dry Skim Milk: Av. wholesale price per lb.
47	(I)-.790	(III).635	Real Retail Price of Delivered Milk
69	(I)-.682	(III).680	Consecutive Time Trend
			Indeterminate
10			Milk: Av. wholesale price per 100 lb. received by farmers
12			Milk - feed price ratio
34			Fluid Milk Marketing Margin
57			Real Wholesale Price of Milk

Several variables had a complex structure in this analysis. Variable #1, Milk Production on Farms, had factor loadings on Factor II, the milk production factor, and on Factor IV, the retail milk price factor. From the directions of the factor loadings of the other variables in these factors, it can be seen that this milk production variable conformed directly with the milk production factor and inversely to the retail milk price factor. This indicates that the retail price of milk fluctuated somewhat inversely to milk production during this period.

The average price for dry skim milk had a positive factor loading on Factor I and on Factor VI. This shows that the dry skim milk wholesale price was influenced directly by both the general price level factor and the real wholesale dry skim milk price factor.

The complex factor structure for the Real Retail Price of Delivered Milk, #47, indicates that this variable fluctuated inversely to the general price level factor and directly with the industrial activity factor. It is interesting that this variable showed no influence of the retail milk price factor, Factor IV, but instead showed the influence of these other two factors. This structure indicates that as the general price level factor increased, the real retail price of milk decreased during this period, while as the industrial activity factor increased, the real retail price of milk also increased.

The Consecutive Time Trend, #69, showed negative loadings

on Factor I and positive loadings on Factor III. This relationship to the general price level factor and the industrial activity factor is similar to that obtained for this variable in the analysis of General Economic Conditions.

Several variables had an indeterminate structure in this analysis. The Average Wholesale Price of Milk, #10, showed an indeterminate structure in the rotated matrix even though it had quite a high factor loading on Factor I in the original orthogonal matrix. Thus it appears that there was some effect of the general price level on this variable even though other factors were also to be considered in the explanation of the variations which occurred.

The Milk-Feed Price Ratio showed an indeterminate structure in this analysis, having minor factor loadings on Factors I, II and III. This is consistent with the findings in previous analyses that this variable, representing the feed factor discussed earlier, was relatively independent of other factors.

The fluid milk marketing margin and the real wholesale price of milk both had inconclusive structures, although both showed positive loadings on Factor III, the industrial activity factor. This indicates a direct relationship existed between the industrial activity factor and these variables, as the relative changes which occurred in them were in the same direction. However, the orthogonal matrix shows that Factor I, the general price level factor, and Factor II, the milk production factor also influenced these variables

somewhat, even though none of these factors have truly significant factor loadings in the rotated matrix.

In summary, there were six factors determined in this analysis. These were a general price level factor, a milk production factor, an industrial activity factor, a retail milk price factor, a monthly seasonal trend factor, and a real wholesale dry skim milk price factor. Together these factors accounted for over 80 percent of the variations in 16 out of the 20 variables included in this analysis. However, the last three factors appear to be overdetermined in this analysis and cannot be considered too reliable.

Estimation of Disappearance of Fluid Milk and Cream

One variable was selected to represent each of the factors described above in the regression system for the estimation of the disappearance of fluid milk and cream. There were two exceptions made to this. The monthly time trend factor was eliminated, since it was felt that this applied solely to the Department Store Sales variable and was extraneous to the rest of the analysis. The real wholesale dry skim milk factor was also eliminated, since it applied primarily to dry skim milk prices and was extraneous to the rest of the analysis.

Variable #65, the Consumer Price Index advanced one month, was selected to represent the general price level factor. Even though this variable was not included in the

factor analysis described above, it was used in the regression system since it was considered a good indicator of the general price level factor in the analysis of General Economic Conditions. Variable #64, Real Purchasing Power advanced two months, was selected to represent the industrial activity factor even though this variable was not included in this analysis. This selection was on the basis of the representative nature of variable #64 in the analysis of General Economic Conditions, also. Variable #1, Milk Production on Farms, was selected to represent the milk production factor, and the Average Retail Price of Delivered Milk, #19, was used to represent the retail milk price factor. The disappearance of fluid milk and cream was the dependent variable in the regression system; the variables listed above were the independent variables.

The coefficient of multiple correlation in this system was $r = .8768$, while the coefficient of determination was $r^2 = .7688$. Thus these variables explained approximately 77 percent of the variations which occurred in fluid milk and cream disappearance during the period 1929-1941. The coefficient of real purchasing power advanced two months proved to be not significant in the regression system, but the coefficients of the other three variables, consumer purchasing power advanced one month, retail milk prices, and milk production, were all highly significant in this system.

A second regression system was set up using only the

consumer price index advanced one month and retail milk prices as independent variables and fluid milk and cream disappearance as the dependent variable. This system eliminated the variable which was not significant in the above system; it also eliminated the production variable in order to see how much effect this production variable had on the system.

In this second regression system, the coefficient of multiple correlation was $r = .3749$, and the coefficient of determination was $r^2 = .1405$. This shows that the consumer price index advanced one month and the price of milk only explained 14 percent of the variations in fluid milk and cream disappearance. Since the previous regression system explained 77 percent of these variations, approximately 63 percent of the variations in fluid milk and cream disappearance were accounted for by fluid milk production during this period.

Comparison of Analyses

There were four factors determined in the analysis which covered 1929-1948 and six factors determined in the analysis which covered 1929-1941. The four factors of Analysis I had counterparts in Analysis II, while the two remaining factors of Analysis II fitted into the factor structure of Analysis I without appearing as separate factors.

Factors I and II, the general price level factor and the

industrial activity factor, in Analysis I had counterparts in Factor I and Factor III of Analysis II. However, more variables showed the influence of these factors in Analysis I than in Analysis II. There was a milk production factor in each analysis which contained the variables of seasonal milk production trend and fluid milk and cream disappearance. The milk production variable also appeared in this factor cluster in Analysis I although it showed a complex structure in Analysis II.

The real wholesale dry skim milk price factor appeared in both Analysis I and Analysis II. The variable of real wholesale milk prices had an indeterminate structure in the period 1929-1941, but it appeared to be largely influenced by this factor during the period 1929-1948.

A retail milk price factor appeared in Analysis II although it did not appear in Analysis I. In Analysis I the retail milk price variable appeared as part of the general price level factor. From the orthogonal and rotated structures of Analysis II, it can be seen that the general price level factor also influenced the retail milk price variable in Analysis II even though other factors were operative, also. Actually, this retail milk price factor probably was not too significant in the analysis, since indications are that it was overdetermined in the factor analysis structure.

A seasonal trend factor appeared in Analysis II which involved the Department Store Sales variable. Since this

factor did not affect any of the variables involving fluid milk and cream, it was considered extraneous in this analysis.

The factor structures for the two analyses discussed above were quite similar. A general price level factor, an industrial activity factor, a milk production factor, and a real wholesale dry skim milk price factor were determined in both analyses. The retail milk price factor in Analysis II was perhaps overdetermined; hence, it probably should not have appeared as a separate factor. The monthly seasonal trend factor determined in Analysis II was considered extraneous to this analysis.

Regression systems were set up using the results of these analyses. In each the coefficient of multiple correlation was approximately r = .87, although different independent variables were used in these systems. To investigate how well these systems would fit present-day conditions, they were extrapolated to 1949 and 1950 and the estimated disappearance of fluid milk and cream for the two years was computed using first the equation derived from Analysis I, 1929-1948, and then the equation derived from Analysis II, 1929-1941. These estimates of the disappearance figures, plus the actual disappearance figures, appear in Table XV.

It can be seen that, although the estimates from Analysis II are much lower than the actual disappearance, the estimates from Analysis I approximate the disappearance figures quite closely. This indicates that a shift in demand might have taken place from 1941 to 1948 so that the estimates derived

Table XV. Actual and Estimated Disappearance of Fluid Milk in 1949 and 1950

(Million Pounds)

	Actual Disappearance	I Estimated Disappearance	II Estimated Disappearance
1949			
January	5,176	5,175	4,080
February	4,899	4,900	4,040
March	5,270	5,375	4,420
April	5,394	5,300	4,760
May	5,752	5,875	5,260
June	6,090	5,875	5,280
July	5,906	5,875	5,160
August	5,292	5,675	4,900
September	5,009	5,150	4,520
October	5,200	5,200	4,420
November	5,105	4,950	4,160
December	5,131	5,200	4,300
Total	64,224	64,550	55,300
1950			
January	5,380	5,200	4,440
February	5,075	5,150	4,300
March	5,417	5,400	4,640
April	5,593	5,600	4,980
May	5,780	5,800	5,240
June	6,056	6,050	5,580
July	6,073	5,775	5,220
August	5,507	5,500	4,840
September	5,218	5,300	4,580
October	5,351	5,325	4,460
November	5,316	5,050	4,120
December	5,449	5,400	4,240
Total	66,214	65,550	56,740

from the period 1929-1941 would no longer fit 1949 or 1950, whereas the estimates derived from the entire period 1929-1948 could closely approximate 1949 and 1950.

The factor structure for Analysis I indicated that the real wholesale prices of milk and dry skim milk were relatively independent of the other prices in the group, while wholesale milk prices, dealers milk prices for city distribution, retail milk prices and dry or powdered whole milk prices all followed the trend of the general price level factor. Approximately the same results were obtained in Analysis II, although in the latter case the factor structure was not as well defined as in Analysis I.

The real retail price of milk was opposite in direction to the general price level factor, indicating that as the general price level increased the real retail price of milk decreased. This also indicated that the retail price of milk was not as flexible as the general price level and did not fluctuate as readily as the general price level.

Although the regression systems based on the factor analyses yielded correlation coefficients of approximately .87 in each system the simple correlation between fluid milk and cream disappearance and total milk production was over .75, signifying that the production variable accounted for over 60 percent of the variations in the disappearance while all of the other variables accounted for approximately 10 percent of the variations in the disappearance of fluid milk and cream. There is also a question as to whether the

production variable should be included at all, since disappearance (as a measure of demand) should theoretically be explainable in terms of prices or general conditions, but not in terms of the supply. Even though supply, in this case, refers to total milk production, and disappearance refers to that portion which is used for fluid milk and cream, there is still the question whether this supply variable ought to have been included at all. As was shown above, excluding the supply variable from the regression systems greatly reduced the strengths of the correlations.

The close correspondence which occurred between production and disappearance might be explained in another way, however. The disappearance of fluid milk and cream was calculated as a residual, deducting the milk equivalent of several manufactured dairy products from total milk production. A more accurate method of calculating these disappearance figures might help to improve these regression systems.

# # # # # # # # #

BUTTER

All of the variables included in this study which pertained to butter were included in this group. Among these were butter production, butter disappearance, oleomargarine production, the butterfat-feed price ratio, butter and oleo prices, the index of retail food prices, marketing margins on dairy products, department store sales and time trend variables. A complete list of the variables in this

group is given in Table XVI.

Analysis I 1929-1948

There were four distinct factors in this analysis. A summary of the factor structure is given in Table XVII.

Factor I contained variables of wholesale and retail prices of butter, the retail food price index, and the retail cost of the market basket. These indicate that factor I was the general price level factor discussed previously. The presence of Payrolls in Manufacturing Industries, #29, and Department Store Sales, #39, in this factor indicates that an industrial activity factor might also be present here; however, this industrial activity factor did not appear as an independent factor.

It appears that Oleo Production was directly influenced by the general price level factor while Butter Disappearance, #73, was inversely influenced by this general price level factor. This latter variable was the only one which showed a negative factor loading on Factor I, indicating that as the price level decreased butter disappearance increased, while as the price level increased butter disappearance decreased. (These changes would be in relative, rather than absolute, terms.)

Factor II contained the variables of butter production, the monthly time trend and the seasonal trend of milk production. This was probably a butter production factor. The factor loadings showed that butter production followed the

Table XVI. Variables Used in Analysis of Butter

	Variable No.	Description
1.	2	Creamery Butter Production
2.	8	Oleomargarine Production
3.	9	Butterfat - Av. Price per lb. received by Farmers
4.	11	Butterfat - feed price ratio
5.	14	Milk - Av. price per cwt. paid producers for 3.5 milk at condenseries
6.	17	Butter - Av. wholesale price per lb.
7.	22	Butter - Av. retail price per lb.
8.	23	Oleomargarine - Av. retail price per lb.
9.	25	Retail Food Prices in Large Cities
10.	29	All Manufacturing Industries - Payrolls
11.	32	Retail Cost of Dairy Products
12.	33	Margin on Dairy Products
13.	35	Butter Marketing Margin
14.	39	Department Store Sales
15.	50	Real Retail Price of Butter
16.	51	Real Retail Price of Oleomargarine
17.	56	Real Wholesale Price of Butterfat
18.	67	Monthly Time Trend
19.	69	Consecutive Time Trend
20.	72	Seasonal Milk Production Trend
21.	73	Monthly Disappearance of Butter

Table XVII. Summary of Factor Structure of Butter

Analysis I 1929-1948 (4 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
		Factor I
8	.611	Oleomargarine: Production
9	.669	Butterfat: Av. price per lb. received by farmers
14	.679	Milk: Av. price per cwt. at condenseries
17	.679	Butter: Av. wholesale price per lb.
22	.638	Butter: Av. retail price per lb.
25	.675	Retail Food Prices in Large Cities
29	.866	Payrolls in Manufacturing Industries
32	.683	Retail Cost of Dairy Products in Market Basket
33	.659	Marketing Margin on Dairy Products
39	.611	Department Store Sales
73	-.607	Butter: Disappearance
		Factor II
2	-.711	Butter: Production
67	.673	Monthly Time Trend
72	-.756	Seasonal Milk Production Trend
		Factor III
35	-.605	Butter Marketing Margin
51	-.552	Real Retail Price of Oleomargarine
		Factor IV
11	.551	Butterfat - Feed Price Ratio

Table XVII. Summary of Factor Structure of Butter (Continued)

Analysis I 1929-1948 (4 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
		Complex
56	(I).557 (IV).523	Real Wholesale Price of Butterfat
69	(I).895 (III).578	Consecutive Time Trend
		Indeterminate
23		Oleomargarine: Av. retail price per lb.
50		Real Retail Price of Butter

seasonal trend of milk production and was inverse to the monthly time trend.

Factor III contained the variables of the butter marketing margin and the real retail price of oleo. From the factor loadings in the rotated matrix this might have been a real retail oleo price factor; however, this was difficult to determine from the limited information available.

The Butterfat-Feed Price Ratio variable, #11, was the only variable with simple structure in Factor IV. Factor IV might thus have been the feed factor discussed earlier, as this was the only factor containing variable #11 in this study.

Two factors showed complex structure in this analysis. The Real Wholesale Price of Butterfat, #56, had positive loadings in Factor I and Factor IV. This indicates that the real wholesale price of butterfat was directly influenced by the general price level factor and also by the feed factor. The consecutive time trend variable also had a complex structure. The factor loadings indicated a direct relationship with the general price level factor and an inverse relationship with the real retail oleo price factor. This latter relationship indicates that the real retail oleo price decreased over time.

Two variables showed an indeterminate structure in this analysis. The Average Retail Price of Oleo, #23, had an indeterminate structure in the rotated matrix; inspection of the orthogonal matrix, however, shows that this variable

was influenced by Factor I, the general price level, and Factor III, the real retail oleo price factor. The Real Retail Price of Butter, #50, showed some influence of the general price level factor and the feed factor, but these were minor factor loadings; hence this variable was classed as indeterminate in structure.

In summary, there were four factors determined in this study. These were a price level factor, a butter production factor, a real retail oleo price factor, and a feed factor. There was also some indication of an industrial activity factor. These factors accounted for over 80 percent of the variations in 11 out of the 21 factors included in this group. Other, perhaps unique, factors would have to be considered in order to explain the variations in the other ten variables.

Estimation of Butter Disappearance

One variable was selected to represent each of the above factors in a regression system for the estimation of butter disappearance. Variable #65, the Consumer Price Index advanced one month, was chosen to represent the general price level factor; Butter Production, #2, represented the butter production factor; the Real Retail Price of Oleo, #51, represented the retail oleo price factor; the Butterfat-Feed Price Ratio, #11, represented the feed factor. These were all independent variables in the regression system. Butter Disappearance, #73, was the dependent variable in this system.

The coefficient of multiple regression obtained from this system was $r = .7727$; the coefficient of determination was $r^2 = .5970$.

There was some question as to whether there was an industrial activity factor included in this group. A second regression system was set up including all of the variables of the first system and adding Real Purchasing Power advanced two months, #64, representing the industrial activity factor. This system yielded a coefficient of multiple correlation of $r = .8326$, with a coefficient of determination of $r^2 = .6933$. Thus the addition of the industrial activity factor explained an additional 10 percent of the variation in butter disappearance. In this second regression system the real retail price of oleo and the butterfat-feed price ratio proved to be not significant to the relationship; the consumer price index, real purchasing power, and butter production variables proved to be highly significant in the system.

A third regression system was set up using the variables found to be significant in the above system but eliminating the butter production variable. This system thus included butter disappearance as the dependent variable with the consumer price index advanced one month and real purchasing power advanced two months as the independent variables. This system yielded a coefficient of multiple regression of $r = .7854$ with a coefficient of determination of $r^2 = .6168$. Thus the factors of general economic conditions explained 61 percent of the variations in butter disappearance while

butter production explained another 8 percent of these variations.

In order to investigate the influence of the retail price of butter in these regression systems, this variable was substituted for the Consumer Price Index advanced one month while all of the other variables of the second regression system discussed above were retained. This yielded a coefficient of multiple correlation of r = .8306, while the previous correlation was r = .8326. Thus the same results were obtained whether the consumer price index or the retail price of butter was used in the regression system.

Analysis II 1929-1941

There were four factors determined in this analysis. A summary of the factor structure is given in Table XVIII.

Factor I appeared to be the general price level factor described previously, since it contained variables of wholesale and retail prices. The fact that variable #29, Payrolls in Manufacturing Industries, appeared in this factor also is evidence that an industrial activity factor might also have been present; however, this industrial activity factor did not appear as a separate factor.

Factor II contained the variables of butter production and the seasonal trend of milk production. It might be considered a butter production factor.

Factor III contained the variables of retail oleo prices, real retail oleo prices, the butter marketing margin, and the

consecutive time trend. The factor loadings indicate that this might have been a real retail oleo price factor. The negative factor loading for the consecutive time variable indicated that the relative sizes of the other variables in this factor decreased over time.

Factor IV contained the variables of department store sales and monthly seasonal trend. This was probably a monthly seasonal trend factor; this same factor appeared in the analysis of Fluid Milk and Cream.

The Butter Disappearance variable, #73, showed a complex structure with factor loadings on Factor II, the butter production factor, and Factor IV, the monthly seasonal trend factor. The influence of the butter production factor is understandable; however, the effect of the monthly seasonal trend factor is more difficult to explain. Perhaps the loading on Factor IV reflects a similar pattern to Department Store Sales. In this case the factor actually operating might have been the industrial activity factor, since the analysis of General Economic Conditions showed that Department Store Sales were influenced by the industrial activity factor during this period.

The Butterfat-Feed Price Ratio, #11, had an indeterminate structure in this analysis. Previous analyses have shown that this variable was part of a feed factor which was relatively independent of the other factors. The indeterminate structure of this variable in this analysis showed that the feed factor was of minor significance.

Table XVIII. Summary of Factor Structure of Butter

Analysis II 1929-1941 (4 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
		Factor I
8	.626	Oleo: Production
9	.707	Butterfat: Av. price per lb.
14	.687	Milk: Av. price per cwt. at condenseries
17	.704	Butter: Av. wholesale price per lb.
22	.697	Butter: Av. retail price per lb.
29	.829	Payrolls in Manufacturing Industries
32	.669	Retail Cost of Dairy Products in Market Basket
50	.740	Real Retail Price of Butter
56	.784	Real Wholesale Price of Butterfat
		Factor II
2	.752	Butter: Production
72	.740	Seasonal Milk Production Trend
		Factor III
23	.542	Oleo: Av. retail price per lb.
35	.663	Butter Marketing Margin
51	.514	Real Retail Price of Oleo.
69	-.745	Consecutive Time Trend
		Factor IV
39	-.651	Department Store Sales
67	-.630	Monthly Time Trend

Table XVIII. Summary of Factor Structure of Butter (Continued)

Variable No.	Factor Loading (Rotated Matrix)	Description
		Complex
73	(II).506 (IV)-.543	Butter Disappearance
		Indeterminate
11		Butterfat - feed price ratio
25		Retail Food Prices in Large Cities
33		Marketing Margin on Dairy Products

Retail Food Prices in Large Cities, #25, showed an indeterminate structure in the rotated matrix, but inspection of the orthogonal matrix shows that the general price level had a large influence on this variable which the rotation process covered up. The Marketing Margin on Dairy Products, #33, also showed an indeterminate structure. Both of these variables showed factor loadings on Factor I, the general price level factor, and Factor III, the real oleo price factor, but these loadings were not high enough to determine what factors had predominately influenced these variables in this analysis. Since a real oleo price factor should not have influenced these variables to any extent, this might indicate that the real retail oleo price factor actually represents some other factor. It was,however, impossible to determine this other factor from the information at hand.

In summary, there were four distinct factors in this analysis. These were a general price level factor, a butter production factor, a real retail oleo price factor, and a monthly seasonal trend factor. There was also some indication that an industrial activity factor might be present, although this was not a distinct factor. The factor structure also indicated that the real retail oleo price factor was actually an indicator of some other factor, but this other factor could not be determined from the information available.

The four distinct factors determined in this analysis

explained over 80 percent of the variations in 11 out of the 21 variables included in this group.

Estimation of Butter Disappearance

One variable was selected from each of the above factors for a regression system estimating butter disappearance. The Consumer Price Index advanced one month, #65, represented the general price level factor, Butter Production, #2, represented the butter production factor, and the Real Retail Price of Oleo, #51, represented the real retail oleo price factor. The monthly time trend factor was considered extraneous to the analysis, but the industrial activity factor was substituted to account for the relationship between butter disappearance and department store sales; Real Purchasing Power advanced two months, #64, was used to represent this industrial activity factor. These variables were the independent variables in the regression system; Butter Disappearance, #73, was the dependent variable in the analysis.

The coefficient of multiple correlation in this system was $r = .5120$, with a coefficient of determination of $r^2 = .2621$. The coefficients of the consumer price index and real purchasing power variables were not significant in this system; only the coefficients of butter production and real retail oleo price proved significant in the regression equation.

In order to investigate the effect of the retail price of

butter in this system, this variable was substituted in place of the Consumer Price Index advanced one month. This system yielded a coefficient of multiple correlation of $r = .5494$, whereas the earlier system had a coefficient of multiple correlation of $r = .5120$. Thus this substitution of variables made little difference in the correlation coefficient.

Comparison of Analyses

There were four distinct factors determined in each of the analyses discussed above. A general price level factor, a butter production factor and a real retail oleo price factor were derived in each analysis. Also, evidences of an industrial activity factor were found in each analysis, although this was not a distinct factor. A feed factor was determined in Analysis I, whereas a monthly seasonal trend factor was derived in Analysis II.

In Analysis I Butter Disappearance was a part of the general price level factor, although it was influenced inversely by this factor. Thus as the general price level increased, Butter Disappearance decreased. In Analysis II Butter Disappearance had a complex structure, showing a relationship with the butter production factor and the monthly seasonal trend factor. This difference might be explained by the shift in the demand for butter which apparently took place in recent years.

The regression system set up from Analysis I explained

69 percent of the variation in butter disappearance over the period 1929-1948. The regression system set up from Analysis II explained only 26 percent of the variation in butter disappearance over the period 1929-1941 although essentially the same variables were used in both analyses.

In Analysis I the consumer price index, real purchasing power, and butter production variables proved significant in the analysis. The consumer price index and real purchasing power explained approximately 61 percent of the variations in butter disappearance, while butter production explained another 8 percent of these variations.

These results directly contradict a statement made by E. E. Vial (14) in 1940. He said: "Changes in industrial production, employment, and payrolls have little or no effect on the consumption of butter. Consumption is governed by production" (14, pp. 6). The results of the factor structure and the regression systems in Analysis I indicate that consumption was not governed primarily by production in this period and that the factors of industrial production and the general price level explained at least 61 percent of the variations in butter disappearance.

In Analysis II, however, the consumer price index and real purchasing power were not significant in the regression system; the only significant variables were those of butter production and the real retail price of oleomargarine. These variables only explained 26 percent of the variations in butter disappearance.

Thus it appears that the statement quoted above by Vial may have been true prior to 1940, although there was not too great a correspondence between production and consumption even at that time. During the period 1929-1948 his statement was contradicted completely.

In order to investigate how well the regression systems would approximate present-day conditions they were extrapolated for 1949 and the estimated disappearance computed for each system. The estimated butter disappearance as estimated by regression systems I and II and the actual disappearance figures are given in Table XIX. It can be seen that I estimated the disappearance fairly closely, while II yielded estimates which were much higher than the actual figures. This is another indication of the downward shift in the demand for butter between these two periods.

Table XIX. Actual and Estimated Disappearance of Butter in 1949

(Million Pounds)

	Actual Disappearance	I Estimated Disappearance	II Estimated Disappearance
1949			
January	106	95	143
February	100	95	143
March	112	101	147
April	110	101	150
May	121	113	157
June	101	113	157
July	99	107	154
August	112	107	153
September	105	104	149
October	107	102	149
November	100	99	148
December	97	102	149
Total	1,270	1,239	1,799
1950			
January	119	101	149
February	108	102	149
March	125	114	152

CHEESE

All of the indices relating to cheese including production, prices and monthly disappearance have been included in this group. In addition, indices of the average price of betterfat, the average wholesale price of milk, the butterfat feed and milk-feed price ratios, the buying price for milk for city distribution, and various time trends have also been included. The two indices of General Economic Conditions, Real Purchasing Power advanced two months, #64, and the Consumer Price Index advanced one month, #65, were included to investigate how they fit into the factor structure. A complete list of the variables in this group is given in Table XX.

Analysis I 1929-1948

There were five factors in this analysis. A summary of the factor structure is given in Table XXI.

Factor I was the general price level factor described previously. This was determined by the presence of the Consumers Price Index advanced one month, #65, which represented the general price level factor in this analysis. The variables which were influenced primarily by this factor were the average buying price for milk for city distribution, the average price paid at condenseries, the average wholesale price and average retail price of cheese, the retail cost of dairy products in the market basket and the marketing

margin on dairy products. These are all consistent with the hypothesis that Factor I was the general price level factor.

Factor II was composed of two variables, the Real Wholesale Price of Butterfat, #56, and the Real Wholesale Price of Milk, #57. This factor was somewhat related to Factor I but was relatively independent of the other factors in this analysis. This factor could be considered to be an indicator of the real wholesale price of milk.

Factor III consisted of cheese production, cheese disappearance, and the seasonal trend of milk production. This factor showed a slight relationship with Factor IV, but it was relatively independent of the other factors. This factor was probably an indicator of cheese production. The factor loadings indicate that the production of cheese closely followed the seasonal pattern of milk production. The fact that cheese disappearance was part of this same factor but with a smaller factor loading shows that cheese disappearance was influenced by cheese production, but that there was not an exact correspondence between the two.

Closer examination of the rotated matrix shows that the price level factor had some slight effect on cheese disappearance but that the cheese production factor had the highest factor loading on cheese disappearance. This signifies that cheese disappearance depended more upon cheese production than on the price of cheese. This indicates that the demand for cheese is inelastic with respect to the price of cheese.

However, the factors determined here only explained about 63 percent of the variations occurring in cheese disappearance; hence other, perhaps unique, factors must be considered before the net effects of the factors could be predicted.

Factor IV consisted of the Butterfat-Feed Price Ratio, #11, and the Milk-Feed Price Ratio, #12. These constitute the Feed Factor described in the previous analysis on Prices. As was stated before, this factor was somewhat related to Factor III, the Cheese Production factor. The Feed factor was relatively independent of all other factors in this analysis.

Factor V contained the variables of the real wholesale price of cheese at Chicago and on the Wisconsin Cheese Exchange. It is interesting that these real wholesale prices, although related to each other, were independent of every other factor in this analysis including the factor containing the real wholesale prices of milk and butterfat (Factor II). Thus this Real Wholesale Cheese Price factor was not influenced by the Real Wholesale Milk Price factor.

A complex structure was obtained for three variables in this analysis. The American Cheese Marketing Margin was associated with Factors I and II. The positive loading on Factor I shows that it was influenced directly by the general price level; the negative loading on Factor II shows that it had an inverse relationship with the real wholesale milk price. The high loading on Factor I appears to be a distortion due to the rotation process; reference to the orthogonal

Table AX. Variables Used in Analysis of Cheese

	Variable No.	Description
1.	3	Cheese, Total Factory Production
2.	9	Butterfat, Av. price per lb. received by farmers
3.	10	Milk, Av. wholesale price per 100 lb. received by farmers
4.	11	Butterfat - feed price ratio
5.	12	Milk - feed price ratio
6.	13	Milk - Av. dealer's buying price per cwt. for city distribution
7.	14	Milk - Av. price per cwt. paid producers for 3.5 milk delivered at condenseries
8.	15	Cheese - fresh, single daisies, Av. wholesale price per lb. at Chicago
9.	16	Cheese - Am. twins, Wholesale price on Wisconsin Cheese Exchange
10.	21	Cheese, Av. retail price per lb. in leading cities
11.	32	Retail Cost of Dairy Products
12.	33	Marketing Margin on Dairy Products
13.	36	American Cheese Marketing Margin
14.	43	Cheese, Real wholesale price per lb. at Chicago
15.	44	Cheese, Real wholesale price per lb. on Wisconsin Cheese Exchange
16.	49	Real retail price of cheese
17.	56	Real wholesale price of butterfat
18.	57	Real wholesale price of milk
19.	64	Real Purchasing Power advanced 2 months
20.	65	Consumer Price Index advanced 1 month
21.	67	Monthly Time Trend
22.	68	Consecutive Time Trend
23.	72	Seasonal Milk Production Trend
24.	74	Monthly Disappearance of Cheese

Table XXI. Summary of Factor Structure of Cheese

Analysis I 1929-1948 (5 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
		Factor I
13	.533	Milk, Av. buying price per cwt. for city distribution
14	.525	Milk, Av. price per cwt. at condenseries
15	.530	Cheese, Av. wholesale price per lb. at Chicago
16	.514	Cheese, Av. wholesale price on Wisconsin Cheese Exchange
21	.526	Cheese, Retail price per lb.
32	.531	Retail Cost of Dairy Products in Market Basket
33	.676	Marketing Margin on Dairy Products
65	.521	Consumers Price Index advanced one month
		Factor II
56	.494	Real wholesale price of Butterfat
57	.523	Real wholesale price of Milk
		Factor III
3	-.613	Cheese Production
72	-.618	Seasonal Milk Production Trend
74	-.494	Cheese Disappearance
		Factor IV
11	.687	Butterfat - feed price ratio
12	.619	Milk - feed price ratio

Table XXI. Summary of Factor Structure of Cheese (Continued)

Analysis I 1929-1948 (5 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
		Factor V
43	.500	Cheese, Real wholesale price at Chicago
44	.490	Cheese, Real wholesale price on Wisconsin Exchange
		Complex
36	(I).819 (II)-.494	American Cheese Margin
49	(I).611 (II)-.612	Real retail price of cheese
64	(II).651 (III) .483	Real purchasing power advanced two months
		Indeterminate
9		Butterfat, Av. price per lb. received by farmers
10		Milk, Av. wholesale price per cwt. received by farmers
67		Monthly Time Trend
69		Consecutive Time Trend

matrix shows that the influence of the general price level in this variable was less than the influence in the variables influenced principally by this factor. The loading on Factor II, however, remains relatively the same in both the orthogonal and rotated matrices.

The Real Retail Price of Cheese, #49, showed a complex structure involving three factors. The loading for the first factor was positive, indicating that the general price level had a direct influence on the real retail cheese price. The negative loading for Factor II indicates that the real retail price of cheese fluctuated in an opposite manner to that of the real wholesale price of milk. This is contradictory to the expected result; it might be due to lags in price changes whereby changes in the real wholesale price of milk and butterfat are only reflected in real retail cheese prices after some time. This might also reflect flaws in the basic data. It is interesting that there was also a positive factor loading on Factor V, the real wholesale cheese price factor. However, this loading was not very large, indicating that the influence of this factor on the real retail price of cheese was not very strong.

The variable indicating the industrial activity factor, #64, had a complex structure in this analysis, having positive loadings on Factor II, the real wholesale milk price factor, and Factor III, the cheese production factor. This complex structure could be interpreted as indicating that no single variable in this analysis was solely influenced by the

industrial activity factor, but that those variables in Factor II and Factor III were influenced to some extent by this factor. The positive loading of variable #64 on factor III was opposite to the loadings of the other variables in this factor. This indicates that cheese production had an inverse relationship with industrial activity. Thus when industrial activity was low cheese production increased, while when industrial activity increased, the production of cheese decreased relative to the proportionate changes occurring.

The average butterfat price received by farmers, #9, and the average wholesale price for milk received by farmers, #10, appeared Indeterminate in structure in the rotated matrix. However, this may have been due to distortions occurring in the rotation process. The original orthogonal structure shows that these two variables had a high loading on Factor I, the general price level factor, and a slight loading on Factor II, the real wholesale milk price factor. Since these results are consistent with the rest of the factor structure, variables #9 and #10 could be considered part of Factor I rather than Indeterminate in structure.

There was no consecutive time trend or monthly time trend evident in this analysis, as both these variables were Indeterminate in the rotated structure and in the orthogonal structure as well.

In summary, there were five factors determined in this analysis of Cheese. These were a general price level factor,

a real wholesale milk price factor, a cheese production factor, a feed factor, and a real wholesale cheese price factor. These five factors explained over 80 percent of the variations in 19 out of the 24 variables included in this analysis.

Estimation of Cheese Disappearance

One variable out of each one of these factors was selected for a multiple regression system. Cheese disappearance was the dependent variable in this system; the five variables chosen as independent variables in this system were the Consumer Price Index advanced one month, #65, Total Factory Production of Cheese, #3, Real Purchasing Power advanced two months, #64, Butterfat-Feed Price Ratio, #11, and Real Wholesale Cheese Price at Chicago, #43. These variables were selected from the factor structure as representatives of the individual factors.

The coefficient of multiple correlation was $r = .7603$. This signifies that these five variables explained 58 percent of the variation in cheese disappearance. However, there was still 42 percent of the variation in cheese disappearance left unexplained by this system. Variables #11 and #43 may be eliminated since they were not significant, and thus did not affect the coefficient of multiple correlation.

A regression system using cheese disappearance as the dependent variable with the consumer price index advanced one month and real purchasing power advanced two months as

independent variables (thus eliminating the cheese production variable) yielded a multiple correlation coefficient of r = .5493. This signifies that these variables explained approximately 30 percent of the variation in cheese disappearance and cheese production explained approximately 30 percent of the variation also.

Analysis II 1929-1941

There were five factors present in this analysis. A summary of the factor structure is given in Table XXII.

Factor I was an indicator of the general price level. This was shown by the presence of the Consumer Price Index advanced one month, #65, which represented this factor from the analysis of General Economic Conditions. The other variables present in this factor were prices of butterfat, milk, and cheese, the retail cost of dairy products in the market basket, and the marketing margin on dairy products. This general price level factor was relatively independent of all other factors in this analysis.

Factor II consisted of the variables of cheese production and cheese disappearance. This factor could be considered a cheese production factor. This factor was relatively independent of every factor but Factor V, which was a time trend factor.

Factor III consisted of the variables of the butterfat-feed price ratio and the milk-feed price ratio. This was

the feed factor discussed previously. It was slightly related to Factor IV, but relatively independent of all other factors in this analysis.

Factor IV involved the real wholesale price of cheese at Chicago and on the Wisconsin Cheese Exchange and the real wholesale price of butterfat. This factor was probably a real wholesale cheese price factor, since the factor loadings for the real wholesale price of cheese were larger than the factor loading of the real wholesale price of butterfat. As was mentioned before, this factor was somewhat related to Factor III, the feed factor. It was relatively independent of all other factors in this analysis.

Factor V consisted of the monthly seasonal time trend and the seasonal milk production trend. It was somewhat related to Factor II, the cheese production factor, but otherwise was completely independent of the other factors. This time factor was probably extraneous to this analysis, since it involved only two time variables and appeared to be independent of the other factors.

A few variables were of complex structure in this analysis. The average price of milk at condenseries and the average wholesale cheese price at Chicago and on the Wisconsin Cheese Exchange all showed approximately the same factor loadings on Factor I, the general price level factor, and Factor IV, the real wholesale cheese price factor. This indicates that the average price of milk at condenseries was influenced by the general price level and by the real wholesale price of cheese.

Table XXII. Summary of Factor Structure of Cheese

Analysis II 1929-1941 (5 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
		Factor I
9	.611	Butterfat, Av. price per lb. received by farmers
10	.621	Milk, Av. wholesale price per cwt. received by farmers
13	.840	Milk, Av. buying price per cwt. for city distribution
21	.868	Cheese, Av. retail price per lb.
32	.863	Retail cost of Dairy Products in Market Basket
33	.866	Marketing Margin on Dairy Products
65	.861	Consumers Price Index advanced one month
		Factor II
3	.585	Cheese Production
74	.615	Cheese Disappearance
		Factor III
11	.782	Butterfat - feed price ratio
12	.743	Milk - feed price ratio
		Factor IV
43	.623	Cheese, Real wholesale price at Chicago
44	.642	Cheese, Real wholesale price on Wisconsin Cheese Exchange
56	.509	Real wholesale price of Butterfat
		Factor V
67	.471	Monthly Time Trend
72	.551	Seasonal Milk Production Trend

Table XXII. Summary of Factor Structure of Cheese (Continued)

Analysis II 1929-1941 (5 factors)

Variable No.	Factor Loading (Rotated Matrix)		Description
			Complex
14	(I) .597	(IV) .402	Milk, Av. price per cwt. at condenseries
15	(I) .527	(IV) .421	Cheese, Av. wholesale price at Chicago
16	(I) .552	(IV) .402	Cheese, Av. wholesale price on Wisconsin Cheese Exchange
36	(I) .885	(IV)-.631	American Cheese Marketing Margin
			Indeterminate
49			Real Retail Price of Cheese
57			Real wholesale Price of Milk
64			Real purchasing power advanced 2 months
69			Consecutive Time Trend

The average wholesale cheese prices at Chicago and on the Wisconsin Cheese Exchange were also influenced principally by the general price level and the real wholesale price of cheese. The sizes of the factor loadings indicate that in each of these cases the general price level factor was somewhat more important than the real wholesale cheese price factor.

The American Cheese Marketing Margin, #36, had a complex structure with a positive loading on Factor I and a negative loading on Factor IV. This indicates that the cheese marketing margin was directly influenced by the general price level and inversely influenced by the real wholesale price of cheese.

Several variables were of indeterminate structure in this analysis. The Real Retail Price of Cheese, #49, showed a positive loading on Factor I, the general price level factor, and a negative loading on Factor V, the seasonal milk production trend factor. The Real Wholesale Price of Milk, #57, showed a positive loading on Factor IV, the real wholesale cheese price factor. However, in both of these cases these factor loadings were minor.

Variable #64, Real Purchasing Power advanced two months, showed positive factor loadings on Factors I, II, and IV, although none of these loadings was large enough to be significant. This indicates that none of these factors was affected primarily by an industrial activity factor, since

variable #64 represented this factor from the analysis of General Economic Conditions. The first four factors in this analysis explained approximately 93 percent in the variation of variable #64, however, signifying that the factor represented by this variable (industrial activity) was present to some extent in each of these factors even though it was not dominant in any one of them.

The consecutive time trend had a negative factor loading on Factor I and positive factor loadings on the other factors, but all of these were minor in size. Hence this time trend could be considered indeterminate in structure.

In summary, there were five factors determined in this analysis. Factor I was the general price level factor; Factor II was a cheese production factor; Factor III was a feed factor; Factor IV was a real wholesale cheese price factor; Factor V was a seasonal milk production trend factor. These five factors accounted for over 80 percent of the variation in 18 out of the 24 variables included in this analysis.

Estimation of Cheese Disappearance

Although five factors appeared in the above analysis, only four were used for estimation purposes. The time factor was eliminated as it appeared to be independent of the other factors in this analysis. Cheese disappearance was the dependent variable in the regression system, while the Consumer Price Index advanced one month represented Factor I, Factory Cheese Production represented Factor II, the

Butterfat-Feed Price Ratio represented Factor III, and the Real Wholesale Cheese Price at Chicago represented Factor IV.

The coefficient of multiple correlation using these variables was r = .7602. However, only the coefficient of cheese production proved to be significant. The simple correlation between cheese production and cheese disappearance was r = .750; therefore the addition of the three other variables added very little to the estimate of cheese disappearance.

Comparison of the Two Analyses

Although there were five factors determined in each analysis, many differences existed in the two factor structures described above.

Factor I, the general price level factor, had the same general characteristics in both analyses. However, the Average Price of Butterfat, #9, and the Average Wholesale Price of Milk, #10, appeared to have simple structure in Analysis II, whereas in Analysis I they were indeterminate in structure. In the latter case, however, it appears that these two variables belonged in the structure of Factor I. The fact that these two variables had smaller loadings than the other variables on Factor I in Analysis II also demonstrates that some other elements should be considered when analyzing variables #9 and #10.

In Analysis I, the Average Price for Milk at Conden-

series, #14, the Average Wholesale Price for Cheese at Chicago, #15, and the Average Wholesale Price for Cheese on the Wisconsin Cheese Exchange, #16, all showed simple structure and appeared to be influenced solely by Factor I. However, in Analysis II these same three variables had complex structures, being composed of both Factor I, the general price level factor, and Factor IV, the real wholesale cheese price factor. It is interesting that, although there was a comparable real wholesale cheese price factor in Analysis I, the variables mentioned above were not influenced by it and depended solely upon the general price level factor. Thus it appears that in the shorter period of time the actual wholesale prices of cheese and the price of milk at condenseries depended on both the general price level and the real wholesale price of cheese, whereas in the longer period of time the major influence on these variables became the general price level.

Variables #13, 21, 32, 33, 65 all retained approximately the same positions in the two time periods.

Factor II, the real wholesale milk price factor, and Factor V, the real wholesale cheese price factor, in Analysis I were merged as Factor IV, the real wholesale cheese price factor, in Analysis II. This demonstrates that, whereas real wholesale cheese prices and the real wholesale price of butterfat followed a similar trend in the period 1929-1941 while the real wholesale price of milk did not follow this trend, over the longer period 1929-1948 the real wholesale

price of cheese followed one trend while the real wholesale price of milk and the real wholesale price of butterfat followed a different trend. This was probably due to the fact that during the shorter period of time the real wholesale price of cheese helped determine the real price of butterfat, while in the longer period other products became of increasing importance and the real wholesale price of butterfat and the real wholesale price of milk reflected these changes.

Factor III, the cheese production factor in Analysis V, was equivalent to Factor IV in Analysis II. However, while the seasonal milk production trend variable was a part of the factor cluster in Analysis I it appeared as a part of a separate factor, Factor V, in Analysis II.

Factor IV, the feed factor in Analysis I, was equivalent to Factor III in Analysis II. The same variables were involved in these factors and they had approximately the same relationship with the other factors.

As mentioned earlier, Factor V together with Factor II in Analysis I were comparable to Factor IV in Analysis II. Factor V in Analysis II, however, did not have a counterpart in Analysis I. Factor V, a time trend factor, was probably a separate factor in Analysis II due to the non-linear aspects of the business cycles affecting the data in the shorter period of time; during the longer period of time the seasonal milk production trend was found to correspond closely to cheese production and became a part of this factor

cluster.

The American Cheese Marketing Margin, #36, exhibited a complex structure in both of these analyses. The Real Retail Price of Cheese, #49, and Real Purchasing Power advanced two months, #64, both had a complex structure in Analysis I while they were indeterminate in structure in Analysis II. This was probably due to the fact that the influences of the factors became more evident and pronounced over the longer period of time. The Consecutive Time Trend, #69, was indeterminate in structure in both these analyses, signifying that there was no evident linear growth pattern present in either of them.

Two regression systems were set up based on the above analyses. In both systems the coefficient of multiple correlation was approximately r = .75 although different variables were used in each. Also, the only variable with a significant coefficient in both these systems was that of cheese production.

In order to investigate how well these systems would estimate recent disappearance, these systems were extrapolated to 1949. The estimated cheese disappearance for 1949 by system I and system II and the actual 1949 disappearance is given in Table XXIII. The estimated disappearance for 1949 based on system II was much lower than the actual disappearance; the estimated cheese disappearance based on system I approximated the actual disappearance more closely even though it was still somewhat lower than the actual figure.

Table XXIII. Actual and Estimated Disappearance of Cheese in 1949

(Million Pounds)

	Actual Disappearance	I Estimated Disappearance	II Estimated Disappearance
1949			
January	88	72.0	55.2
February	83	71.5	54.8
March	99	76.0	62.4
April	100	81.0	66.0
May	113	89.0	66.0
June	80	89.0	66.4
July	78	81.0	66.0
August	81	80.0	66.4
September	88	77.5	62.8
October	88	72.5	58.8
November	85	68.5	54.8
December	88	68.5	54.8
Total	1,071	926.5	734.4
1950			
January	92	72.5	55.6
February	92	73.5	55.6
March	104	77.5	63.2

CONDENSED, DRY AND EVAPORATED MILK

Since there was not enough information available to make a complete analysis of these individual products, condensed, dry and evaporated milk products were analyzed as a single group. This group included all the variables in this study relating to these products such as production, wholesale prices, and retail prices of condensed milk, evaporated milk, and dry and powdered whole and skim milk. The only disappearance figures available for this group were those for evaporated milk and they were included. In addition, other variables such as total milk production on farms, real purchasing power advanced two months, the consumers price index advanced one month, and indicators of the various time trends were used in this analysis. A complete list of the variables included in this group is given in Table XXIV.

Analysis I 1929-1948

There were four distinct factors determined in this analysis. A summary of the factor structure is given in Table XXV.

Factor I contained variables of retail and wholesale prices and the consumer price index advanced one month. This factor was probably the general price level factor discussed previously.

Factor II contained the variables of the real wholesale

Table XXIV. Variables used in Analysis of Condensed, Dry and Evaporated Milk

	Variable No.	Description
1.	1	Milk, Production on Farms
2.	4	Evaporated Milk, unskimmed, case goods production
3.	5	Condensed Milk, skimmed, Production sweetened and unsweetened
4.	6	Dry Whole Milk Production
5.	10	Milk, Av. wholesale price per 100 lb. received by farmers
6.	14	Milk, Av. price per cwt. paid producers for 3.5 milk delivered at condenseries
7.	18	Evaporated Milk, unsweetened, Av. wholesale selling price per case
8.	20	Evaporated Milk, Av. retail price per 14½ oz. can in leading cities
9.	37	Evaporated milk marketing margin
10.	40	Milk, dry or powdered whole, Av. wholesale selling price per lb.
11.	41	Dry Skim Milk, Av. wholesale selling price per lb.
12.	42	Dried or Powdered Skim Milk, Production
13.	46	Real Wholesale Price of Evaporated Milk
14.	48	Real Retail Price of Evaporated Milk
15.	54	Real Wholesale Price of Dry Whole Milk
16.	55	Real Wholesale Price of Dry Skim Milk
17.	64	Real Purchasing Power advanced Two Months
18.	65	Consumers Price Index advance One Month
19.	67	Monthly Time Trend
20.	69	Consecutive Time Trend
21.	72	Seasonal Milk Production Trend
22.	75	Monthly Disappearance of Evaporated Milk

Table XXV. Summary of Factor Structure of Condensed, Dry and Evaporated Milk

Analysis I 1929-1948 (4 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
		Factor I
10	.682	Milk, Av. wholesale price per cwt received by farmers
14	.725	Milk, Av. price per cwt. at condenseries
18	.783	Evaporated Milk, Av. wholesale selling price
20	.821	Evaporated Milk, Av. retail price
40	.725	Milk, Dry or Powdered whole, Av. wholesale selling price
65	.826	Consumers Price Index advanced one month
		Factor II
55	.819	Real wholesale price of Dry Skim Milk
64	.644	Real Purchasing power advanced 2 months
69	.585	Consecutive Time Trend
		Factor III
1	.804	Milk Production
72	.830	Seasonal Milk Production Trend
		Factor IV
46	-.761	Real wholesale price of Evaporated Milk
48	-.747	Real retail price of Evaporated Milk

Table XXV. Summary of Factor Structure of Condensed, Dry and Evaporated Milk (Continued)

Analysis I 1929-1948 (4 factors)

Variable No.	Factor Loading (Rotated Matrix)				Description
					Complex
4	(II)	.576	(III)	.610	Evaporated Milk production
5	(I)	.409	(III)	.667	Condensed Milk production
6	(I)	.436	(II)	.507	Dry whole milk production
37	(I)	.851	(II)	-.545	Evaporated milk marketing margin
41	(I)	.460	(II)	.500	Dry skim milk, Av. wholesale price per lb.
42	(II)	.503	(III)	.588	Dried or powdered skim milk production
54	(I)	.444	(II)	.444	Real wholesale price of dry whole milk
			(IV)	-.529	
					Indeterminate
67					Monthly Time Trend
75					Evaporated Milk Disappearance

price of dry skim milk, real purchasing power advanced two months and the consecutive time trend. This factor appeared to be the industrial activity factor determined in previous analyses.

Factor III contained the variables of milk production and the seasonal milk production trend. From the appearance of the factor structure, this was probably a milk production factor.

Factor IV contained the variables of the real wholesale price of evaporated milk and the real retail price of evaporated milk. This was probably a real evaporated milk price factor. It is interesting that it is virtually independent of Factor II, the industrial activity factor, which contained the variables of the real wholesale price of dry skim milk and real purchasing power.

Several variables showed a complex structure in this analysis. Dry whole milk production and dry skim milk average wholesale prices were influenced by Factor I, the general price level factor, and Factor II, the industrial activity factor. The Evaporated Milk Marketing Margin, #37, showed a direct influence by the general price level factor and an inverse influence by the industrial activity factor. This indicates that as industrial activity increased, this marketing margin decreased, while as industrial activity decreased this margin increased. This is consistent with the behavior of other marketing margins discussed previously.

Condensed Milk Production, #5, showed a complex structure with factor loadings on Factor I, the general price level

factor, and Factor III, the milk production factor. Evaporated Milk Production, #4, and Dried or Powdered Skim Milk Production, #42, showed the influence of Factor II, the industrial activity factor, and Factor III, the milk production factor. Thus, while all three of these products were influenced by a milk production factor with condensed milk production followed the trend of the general price level, evaporated milk and dry skim milk production followed the trend of industrial activity.

The Real Wholesale Price of Dry Whole Milk was influenced by three factors in this analysis. These were the general price level factor, the industrial activity factor, and the real evaporated milk factor.

Two variables showed an indeterminate structure in this analysis. The monthly time trend was not present to any large extent in any of the factors, although it was somewhat contra-seasonal to the milk production factor. Evaporated Milk Disappearance, #75, had minor factor loadings on Factors II, III, and IV, although none of these was large enough to exert a significant influence.

In summary, there were four distinct factors determined in this analysis. These were a general price level factor, an industrial activity factor, a milk production factor, and a real evaporated milk price factor. These factors accounted for over 80 percent of the variations in 14 out of the 22 variables included in this group.

Estimation of Evaporated Milk Disappearance

Since the only actual disappearance figures available for this group were for evaporated milk, a regression system was set up using the results of the above analysis to estimate evaporated milk disappearance. One variable was selected to represent each factor determined in the analysis. The Consumer Price Index advanced one month, #65, represented the general price level factor, Real Purchasing Power advanced two months, #64, represented the industrial activity factor, Milk Production on Farms, #1, represented the milk production factor, and Real Wholesale Price of Evaporated Milk, #46, represented the real evaporated milk price factor. These variables were the independent variables in the regression system; Evaporated Milk Disappearance, #75, was the dependent variable.

The coefficient of multiple regression obtained from this system was $r = .6342$ and the coefficient of determination was $r^2 = .4022$. Thus 40 percent of the variation in evaporated milk disappearance was explained by this system. In this system the coefficient of the consumer price index was not significant, but all the other coefficients were significant.

A second regression system was set up using the real purchasing power variable and real wholesale price of evaporated milk as independent variables and evaporated milk disappearance as the dependent variable. This system gave

a coefficient of multiple correlation of r = .4836 with a coefficient of determination of r^2 = .2338. Thus the total milk production on farms accounted for approximately 17 percent of the variation in the disappearance of evaporated milk, since the above system explained 40 percent of the variation.

Analysis II 1929-1941

There were five distinct factors determined in this analysis. A summary of the factor structure is given in Table XXVI.

Factor I contained indices of wholesale and retail prices and also the consumer price index advanced one month. These indicate that this factor was the general price level factor discussed previously. It is interesting that the Evaporated Milk Marketing Margin, #37, also followed the same pattern as this price level factor.

Factor II contained variable #64, Real Purchasing Power advanced two months. This variable represented the industrial activity factor in this analysis; therefore Factor II was probably this same industrial activity factor. The factor loadings indicate that dry whole milk production was influenced principally by this factor during this period.

Factor III was probably a milk production factor, since the factor cluster contained the variables of milk production on farms and the seasonal milk production. Evaporated milk production was influenced by this milk production

Table XXVI. Summary of Factor Structure of Condensed, Dry and Evaporated Milk

Analysis II 1929-1941 (5 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
		Factor I
10	.852	Milk, av. wholesale price per cwt. received by farmers
14	.887	Milk, av. price per cwt. at condenseries
18	.927	Evaporated Milk, av. wholesale selling price
20	.936	Evaporated Milk, av. retail price
37	.569	Evaporated Milk Marketing Margin
40	.929	Milk, dry or powdered whole; av. wholesale selling price
65	.897	Consumers Price Index advanced one month
		Factor II
6	.478	Dry whole milk production
64	.512	Real purchasing power advanced two months
69	.482	Consecutive Time Trend
		Factor III
1	.765	Milk production on farms
4	.573	Evaporated Milk production
72	.765	Seasonal milk production trend
		Factor IV
55	-.510	Real wholesale price of dry skim milk

Table XXVI. Summary of Factor Structure of Condensed, Dry and Evaporated Milk (Continued)

Analysis II 1929-1941 (5 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
		Factor V
46	.852	Real wholesale price of Evaporated Milk
48	.760	Real retail price of Evaporated Milk
		Complex
5	(I) .643 (III) .654	Condensed milk production
41	(I) .636 (IV)-.689	Dry Skim Milk, av. wholesale price per lb.
54	(I) .501 (V) .670	Real wholesale price of dry whole milk
		Indeterminate
42		Dry or Powdered Skim Milk Production
67		Monthly Time Trend
75		Evaporated Milk Disappearance

factor during this period also.

Factor IV contained only one variable showing simple structure. This was variable #55, the Real Wholesale Price of Dry Skim Milk. This factor was somewhat closely related to Factor II, the industrial activity factor, in the complete factor structure but was relatively independent of the other factors. There was not enough information here to identify this factor so it was called by the name of the variable, a real wholesale dry skim milk factor. Although there was not enough information to identify this factor more completely this does signify that the real wholesale dry skim milk price was relatively unique in this analysis and did not follow the same general trend as the other variables.

Factor V contained the variables of the real wholesale price of evaporated milk and the real retail price of evaporated milk. This might be called a real evaporated milk price factor, although there was not enough information here to identify this factor completely.

A few variables showed a complex structure in this analysis. Condensed Milk Production, #5, showed the influence of the general price level factor and the milk production factor. The wholesale price of dry skim milk showed the influence of the general price level factor and the real wholesale dry skim milk factor. The complex structure of the real wholesale price of dry whole milk involved Factor I, the general price level factor, and Factor V, the real evaporated milk price factor. This indicates that the real wholesale price

followed a pattern similar to the general price level even though the price level had been removed and also a pattern similar to that of evaporated milk prices.

Three variables showed an indeterminate structure in this analysis. Dry or powdered Skim Milk Production, #42, and Evaporated Milk Disappearance, #75, showed minor factor loadings on a few of the factors, but these loadings were not large enough to be significant. The monthly time trend variable showed insignificant loadings on all factors, signifying that no monthly time trend was evident in all factors.

In summary, there were five factors determined in this analysis. These were a general price level factor, an industrial activity factor, a milk production factor, a real wholesale dry skim milk price factor, and a real evaporated milk price factor. These factors explained over 80 percent of the variations in 15 out of the 22 variables included in this group. The real wholesale dry skim milk price factor and the real evaporated milk price factor were not completely determined in this analysis, however. Further information is necessary to determine what these factors actually were.

Estimation of Evaporated Milk Disappearance

A regression system was set up using the results of the above analysis to estimate evaporated milk disappearance. One variable was selected to represent each factor in the analysis. The Consumer Price Index advanced one month, #65,

represented the general price level factor; Real Purchasing Power advanced two months, #64, represented the industrial activity factor; Milk Production on Farms, #1, represented the milk production factor; Real Wholesale Price of Dry Skim Milk, #55, represented the real wholesale dry skim milk price factor; Real Wholesale Price of Evaporated Milk, #46, represented the real evaporated milk price factor. These variables were the independent variables in the regression system; the dependent variable in this system was Evaporated Milk Disappearance, #75.

The coefficient of multiple regression in this system was $r = .7150$ and the coefficient of determination was $r^2 = .5153$. Thus approximately 52 percent of the variation in evaporated milk disappearance was explained by this regression system. In this system, the coefficients of the real wholesale price of dry skim milk and the real wholesale price of evaporated milk proved to be not significant.

A second system was set up using the consumer price index and real purchasing power variables as independent variables, with evaporated milk disappearance as the dependent variable. This system yielded a coefficient of multiple correlation of $r = .5943$ and a coefficient of determination of $r^2 = .3532$. Thus these two indicators of general economic conditions explained 35 percent of the variation in evaporated milk disappearance.

Comparison of Analyses

There were four factors determined in the first analysis and five factors determined in the second. The four factors of the first analysis were all present in the second analysis; one additional factor appeared in the second analysis which apparently merged into the factor structure of the first analysis over the longer period of time.

The four factors present in both analyses were a general price level factor, an industrial activity factor, a milk production factor, and a real evaporated milk price factor. The real wholesale dry skim milk price factor which appeared in Analysis II became a part of the industrial activity factor in Analysis I.

The variables showing simple structure had approximately the same relationships to each other in both analyses. Evaporated milk production, which had a complex structure in Analysis I between the industrial activity factor and the milk production factor, exhibited simple structure in the shorter period of time of Analysis II. In this latter analysis it showed only the influence of milk production.

Dry whole milk production, which showed the influence of both the general price level factor and the industrial activity factor in Analysis I, was influenced only by the industrial activity factor in Analysis II. This indicates that the general price level factor became of increasing importance over the longer period of time in the production of dry whole milk.

Dry or powdered skim milk production had an indeterminate structure in Analysis II, but it showed a complex structure between the industrial activity factor and the milk production factor in the longer period covered in Analysis I.

The evaporated milk marketing margin was influenced solely by the general price level factor in Analysis II, but was influenced also by the industrial activity factor in Analysis I.

Condensed milk production showed the same type of complex structure in both analyses. Both the monthly time trend and evaporated milk disappearance had an indeterminate structure in these analyses.

Regression system I explained 40 percent of the variation in evaporated milk disappearance while regression system II explained 50 percent of this variation. Essentially the same variables were used in both systems. However, while the coefficient of the consumer price index was highly significant in regression system II, it was not significant in regression system I. Exactly the reverse of this situation was true for the coefficient of the real wholesale price of evaporated milk; it was highly significant in regression system I, but it was not significant in regression system II.

In order to investigate how well the regression systems set up on the basis of these analyses would fit present day conditions, they were extrapolated to 1949 and the estimated disappearance from the two series compared with the actual disappearance. These figures are given in Table XXVII. The

estimates from regression system II were much lower than the actual disappearance figures; this indicates that an upward shift in demand might have taken place during 1942-1949. The disappearance estimates from regression system I more nearly approximated the actual disappearance figures; however, the 1949 total was underestimated by almost 10 percent even in regression system I.

Table XXVII. Actual and Estimated Disappearance of Evaporated Milk in 1949

(Million Pounds)

	Actual Disappearance	I Estimated Disappearance	II Estimated Disappearance
1949			
January	242	186	130
February	222	174	126
March	224	202	124
April	218	212	126
May	220	232	142
June	237	232	129
July	204	232	126
August	234	220	117
September	190	196	105
October	202	196	105
November	214	180	111
December	222	192	102
Total	2,629	2,454	1,444
1950			
January	245	192	114
February	217	192	123
March	241	204	132

PRODUCTION AND DISAPPEARANCE OF DAIRY PRODUCTS

All of the data concerning the production and disappearance of dairy products were included in this group. Total milk production on farms, factory production of seven manufactured dairy products, and the production of oleomargarine were included along with the disappearance of four dairy products; in addition representatives of the general price level factor and industrial activity factor were used to investigate how production and disappearance were related to these factors. A complete list of the variables included in this group is given in Table XXVIII.

Analysis I 1929-1948

There were three factors determined in this analysis. A summary of the factor structure is given in Table XXIX.

Factor I included variables of milk production, cheese production, evaporated milk production, and dried or powdered skim milk production. This factor was probably a milk production factor since these products followed the pattern of seasonal milk production. It is interesting that fluid milk and cream disappearance also was a part of this factor structure. This signifies that fluid milk and cream disappearance followed the trend of milk production during this period.

Factor II contained the variables of butter production, oleo production, and butter disappearance. The factor structure indicated that this was probably a butter production factor

Table XXVIII. Variables Used in Analysis of Production and Disappearance of Dairy Products

	Variable No.	Description
1.	1	Milk, Production on Farms
2.	2	Creamery Butter Production
3.	3	Cheese, Total Factory Production
4.	4	Evaporated Milk, unskimmed case goods production
5.	5	Condensed Milk, skimmed; Production sweetened and unsweetened
6.	6	Dry Whole Milk Production
7.	7	Ice Cream Factory Production
8.	8	Oleomargarine Production
9.	42	Dried or Powdered Skim Milk Production
10.	64	Real Purchasing Power advanced two months
11.	65	Consumers Price Index advanced one month
12.	73	Monthly Disappearance of Creamery Butter
13.	74	Monthly Disappearance of Cheese, Whole Milk and Part Skim
14.	75	Monthly Disappearance of Evaporated Milk
15.	76	Monthly Disappearance of Fluid Milk and Cream

Table XXIX. Summary of Factor Structure of Production and Disappearance of Dairy Products

Analysis I 1929-1948 (3 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
	Factor I	
1	.554	Milk production on farms
3	.563	Cheese production
4	.652	Evaporated milk production
42	.534	Dried or powdered skim milk production
76	.482	Fluid milk and cream disappearance
	Factor II	
2	-.828	Butter Production
8	.746	Oleo Production
73	-.764	Butter Disappearance
	Factor III	
74	.504	Cheese Disappearance
75	.328	Evaporated Milk Disappearance
	Complex	
6	(I) .439 (II) .495	Dry Whole Milk Production
64	(I) .507 (II) .652	Real purchasing power advanced 2 months
65	(II) .538 (III) .425	Consumers price index advanced one month
	Indeterminate	
5		Condensed Milk production
7		Ice cream production

The factor loading for oleo production was opposite in sign to those of butter production and disappearance, indicating that oleo production varied inversely with butter production and disappearance.

Factor III contained the variables of cheese disappearance and evaporated milk disappearance. This indicates that these two variables did not follow the trend of the other variables in this analysis. However, this factor was rather closely associated with factor I, the milk production factor, in the rotated factor structure. Thus, although cheese disappearance and evaporated milk disappearance were related to the milk production factor, there were other elements operating to produce the variations in these variables. This might be called a cheese disappearance factor, signifying that this was a separate factor in the analysis.

Three variables showed a complex structure in the rotated matrix. Dry Whole Milk Production, #6, had factor loadings on Factor I, the milk production factor, and Factor II, the butter production factor. This indicates that dry whole milk production did not follow a pattern similar to either of the individual factor patterns, but one which was a combination of the two.

It is significant that Real Purchasing Power advanced two months, #64, and the Consumer Price Index advanced one month, #65, both had complex structures in this analysis. Since these represented the two factors derived from general economic conditions, it appears that the factors representing

the production and disappearance of dairy products did not follow the factors of general economic conditions exactly but were somewhat influenced by these factors. Real Purchasing Power advanced two months, #64, had factor loadings on Factor I, the milk production factor, and Factor II, the butter production factor. This indicates that the industrial activity factor (represented by #64) had some influence on the milk production factor and the butter production factor, even though the industrial activity factor did not follow the patterns of these other factors exactly. Likewise, the Consumer Price Index advanced one month, #65, had factor loadings on Factor II, the butter production factor, and Factor III, the cheese disappearance factor. This indicates that the general price level factor (represented by #65) was influential in the butter production factor and the cheese disappearance factor but did not explain all of the variations in those factors.

Two variables were indeterminate in structure in this analysis. Condensed milk production and ice cream production had minor factor loadings in the rotated factor structure. However, the orthogonal structure indicates that both these variables were largely influenced by the milk production factor even though other, perhaps unique, factors were necessary to explain the remainder of their variations.

In summary, there were three factors determined in this analysis. These were a milk production factor, a butter production factor, and a cheese disappearance factor. Together

these variables explained over 80 percent of the variations in 9 out of the 15 variables included in this group. These factors explained the variations in the production of dairy products rather fully, but did not explain a large part of the variations occurring in the other variables included here. This indicates that the milk production factor was well defined in this analysis but that the other two factors were not as well defined in structure.

Analysis II 1929-1941

There were three factors determined in this analysis. A summary of the factor structure is given in Table XXX.

Factor I contained variables of the production of cheese, evaporated milk, dry whole milk, ice cream, and dried or powdered skim milk and variables of cheese and evaporated milk disappearance. From the factor structure this was probably a milk production factor, since the pattern of milk production played a large part in the production of these products. The appearance of ice cream production in this factor cluster may have been due to a temperature factor very similar in pattern of variation to milk production, since the seasonal demand for Ice Cream followed the same general trend of milk production. It is interesting that evaporated milk disappearance and cheese disappearance followed the same general pattern as milk production, even though other factors where also operative in these variables.

Factor II contained only one variable with simple struct-

Table XXX. Summary of Factor Structure of Production and Disappearance of Dairy Products

Analysis II 1929-1941
(3 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
	Factor I	
3	.914	Cheese Production
4	.895	Evaporated Milk Production
6	.729	Dry whole milk production
7	.881	Ice Cream production
42	.782	Dried or powdered skim milk production
74	.652	Cheese disappearance
75	.525	Evaporated milk disappearance
	Factor II	
65	-.784	Consumers Price Index advanced one month
	Factor III	
8	.768	Oleo Production
64	.651	Real purchasing power advanced 2 months
	Complex	
1	(I) .937 (III)-.506	Total Milk production on farms
2	(I) .910 (III)-.505	Butter production
5	(I) .751 (II)-.701	Condensed milk production
76	(I) .618 (III)-.742	Fluid Milk and Cream disappearance
	Indeterminate	
73		Butter Disappearance

ure. This was the Consumer Price Index advanced one month, #65. Since this variable represented the general price level factor in this analysis, Factor II may be considered this general price level factor.

Factor III contained the variables of Oleomargarine Production and Real Purchasing Power advanced two months, #64. The factor structure indicates that the variable of oleo production had its chief factor loading on this factor. From the appearance of the factor structure this might be considered an oleo production factor. The large factor loading of the variable of real purchasing power indicates that the industrial activity factor (represented by this variable) had a pattern similar to that of the oleo production factor. Factor III is not considered to be the industrial activity factor as variable #64, the representative of this latter factor, had a loading on Factor I which was at least of minor significance. Thus, although Factor III was similar to the industrial activity factor it could not be considered the same factor.

Several variables had a complex structure in this analysis. Total Milk Production on Farms, #1, had a large positive loading on Factor I, the milk production factor, and a negative loading on Factor III, the oleo production factor. This signifies that total milk production on farms and the various dairy production variables in Factor I were closely associated, while milk production had an inverse relationship with oleo production and real purchasing power. Butter production had similar factor loadings on these two variables, showing a

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positive relationship with the milk production factor and an inverse relationship with the oleo production factor. Fluid milk and cream disappearance also had high factor loadings on these two factors; however, the size of these loadings indicated that the direct relationship with the milk production factor was not as great as in the other variables mentioned above, while the inverse relationship between fluid milk and cream disappearance and the oleo production factor was larger than in the other variables.

Condensed milk production, #5, showed a complex structure indicating a direct relationship with Factor I, the milk production factor, and a direct relationsnip with Factor II, the general price level factor.

Butter Disappearance, #73, showed an indeterminate structure in this analysis, with minor factor loadings on all three factors. The three factors only explained about 21 percent of the variations occurring in butter disappearance during this period.

In summary, there were three factors determined in this analysis. These were a milk production factor, a general price level factor, and an oleomargarine production factor. In the factor structure the production factor was fairly well determined; however, the other two factors were not well defined and indications are that, with the inclusion of additional variables, these factors might have changed in composition and importance.

The three variables determined above explained over 80

percent of the variations in only five out of the fifteen variables included in this group. The five variables which were best explained by this analysis were production variables. This is another indication that the milk production factor was well defined while the other factors were not. From this it may be concluded that the grouping of production and disappearance variables did not give enough information for a clearly defined factor analysis during this period.

Comparison of Analyses

There were three factors determined in each of the analyses described above. A milk production factor was found in each analysis; however, the structure of the other two factors changed completely from one analysis to the other.

In Analysis I, Factor II was a butter production factor. The variables comprising this factor in Analysis I changed in the structure of Analysis II; in the latter analysis the butter production variable showed a complex structure, the butter disappearance variable showed an indeterminate structure, and the oleo production variable was considered a part of an oleo production factor which was associated with the variable of real purchasing power. In Analysis I the oleo production variable was also associated with the variable of real purchasing power, but this latter variable showed more of a complex structure in Analysis I than it did in Analysis II.

Factor III in Analysis I was a cheese disappearance factor. The two variables in this factor merged into Factor I, the milk production factor, in Analysis II. Thus, whereas the variables of cheese disappearance and evaporated milk disappearance appeared as a separate factor during the period 1929-1948, they followed the same general trend as the milk production factor during the period 1929-1941. Their appearance as a separate factor during the longer period of time might have been caused by a change in the demand for cheese and evaporated milk.

The variable of the consumer price index appeared as a distinct factor in Analysis II, whereas it showed a complex structure involving the butter production factor and the cheese disappearance factor in Analysis I. This difference might have been caused by the indeterminate nature of the factor structures in these analyses.

In general, it can be said of both these analyses that the milk production factor was fairly well determined in each. The remainder of the variations in each analysis were explained by two further factors, but in each case the factor structure was poorly defined and would probably change on the addition of further variables to this group.

The factor structure indicated that milk production was a significant factor affecting the production of cheese, evaporated milk, fluid milk, and dried or powdered skim milk. This milk production factor was influenced by the industrial activity factor but it was not influenced by the general price

level factor. Thus industrial activity affected the production of milk and the production of these other products, but the general price level had little or no influence on this production. Milk production on farms was negatively affected by industrial activity in the period 1929-1941, but was positively affected by this industrial activity factor in the period 1929-1948.

Butter production did not follow the trend of production of the other products listed above. This might be due to the fact that butter was a residual dairy product; after the requirements for other dairy products were met, the excess milk and cream was made into butter.

There was no general pattern in dairy product disappearance such as appeared in production. Although the general price level factor and the industrial activity factor were of importance in the disappearance variables, there were still other factors which influenced the disappearance of these dairy products. These other factors could not be identified from the nature of the factor structure.

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MARKETING MARGINS

All of the variables relating to the market basket and the marketing margins on the market basket were included in this group. Also included were Real Purchasing Power advanced two months, #64, and the Consumer Price Index advanced one month, #65, as representatives of the factors of general economic conditions which were derived in a previous analysis.

A complete list of the variables in this group is given in Table XXXI.

Analysis I 1929-1948

There were two factors determined in this analysis. Summary of the factor structure is given in Table XXXII. A diagram of the orthogonal factor structure is given in Figure 10.

Factor I contained variables of the retail cost of the market basket, the retail cost of dairy products in the market basket, the marketing margin on dairy products, the fluid milk marketing margin, and the consumer price index advanced one month. This last variable represented the general price level factor in this analysis, and all of the other variables in the factor cluster are consistent with the hypothesis that factor I was this general price level factor.

It is interesting that the Marketing Margin on Dairy Products, #33, followed the same general trend as this general price level factor. The Fluid Milk Marketing Margin, #34, had a similar factor loading, although the marketing margins for the other dairy products were not a part of this factor cluster. This indicates that the fluid milk marketing margin was a predominant part of the marketing margin on dairy products since they both followed similar patterns. This same result was obtained in the analysis of prices.

Table XXXI. Variables Used in Analysis of Marketing Margins

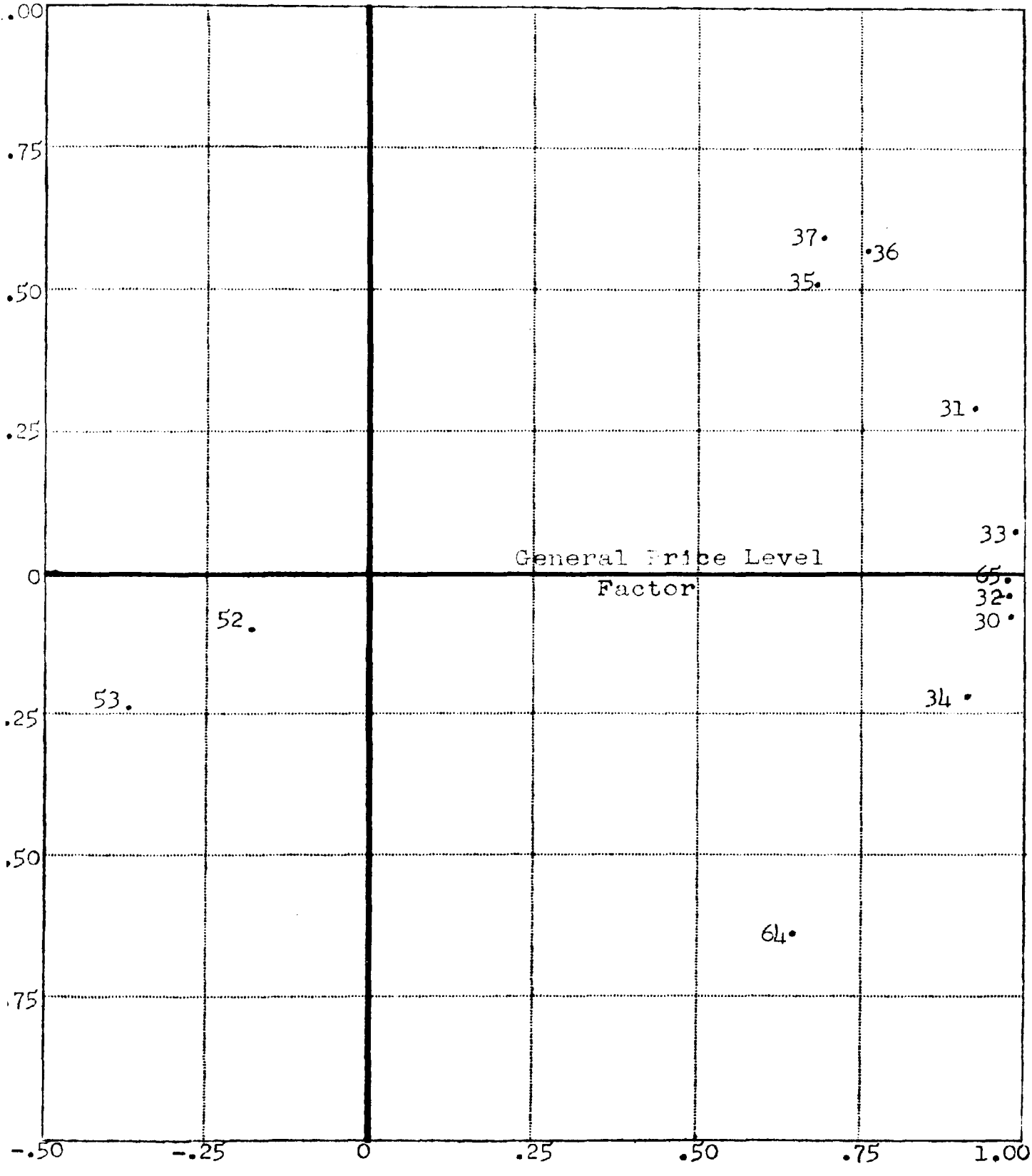
	Variable No.	Description
1.	30	Retail Cost of the Market Basket
2.	31	Marketing Margin on Market Basket
3.	32	Retail Cost of Dairy Products in Market Basket
4.	33	Marketing Margin on Dairy Products
5.	34	Fluid Milk Marketing Margin
6.	35	Butter Marketing Margin
7.	36	American Cheese Marketing Margin
8.	37	Evaporated Milk Marketing Margin
9.	52	Real Retail Cost of the Market Basket
10.	53	Real Retail Cost of Dairy Products in the Market Basket
11.	64	Real Purchasing Power advanced two months
12.	65	Consumer Price Index advanced one month

Table XXXII. Summary of Factor Structure of Marketing Margins

Analysis I 1929-1948 (2 factors)

Variable No.	Factor Loading (Rotated Matrix)	Description
		Factor I
30	.672	Retail Cost of Market Basket
32	.640	Retail Cost of Dairy Products in Market Basket
33	.559	Marketing Margin on Dairy Products
34	.743	Fluid Milk Marketing Margin
65	.616	Consumers Price Index advanced one month
		Factor II
35	.535	Butter Marketing Margin
36	.604	American Cheese Marketing Margin
37	.621	Evaporated Milk Marketing Margin
		Complex
64	(I) .906 (II)-612	Real Purchasing Power advanced one month
		Indeterminate
31		Marketing Margin on Market Basket
52		Real Retail Cost of Market Basket
53		Real Retail Cost of Dairy Products in Market Basket

Figure 10. Orthogonal Factor Structure of Marketing Margins, Analysis I, 1929-1948.



Factor II contained the variables of marketing margins on butter, American cheese, and evaporated milk. This might be considered a manufactured dairy products marketing margin factor. However, the factor structure showed that Factor I and Factor II were rather closely associated and were not independent of each other.

Real Purchasing Power advanced one month, #64, showed a complex structure in this analysis. It had the same structural relationship with #65 as it showed in previous analyses, but it was opposite in direction to Factor II.

Three variables showed an indeterminate structure in this analysis. The Real Retail Cost of the Market Basket, #52, and the Real Retail Cost of Dairy Products in the Market Basket, #53, showed insignificant factor loadings in both the orthogonal and rotated matrices and could be considered as unaffected by the factors determined in this analysis. However, the Marketing Margin on the Market Basket, #31, had minor factor loadings in the rotated matrix but significant factor loadings in the orthogonal matrix. The orthogonal matrix showed that this variable was primarily influenced by the general price level factor; this was probably covered up by the rotation process.

Actually, the orthogonal matrix gave a much better picture of the factor structure than the rotated matrix did for this group. The orthogonal matrix showed that there was a definite general price level factor and a second factor on which the marketing margins for manufactured dairy products

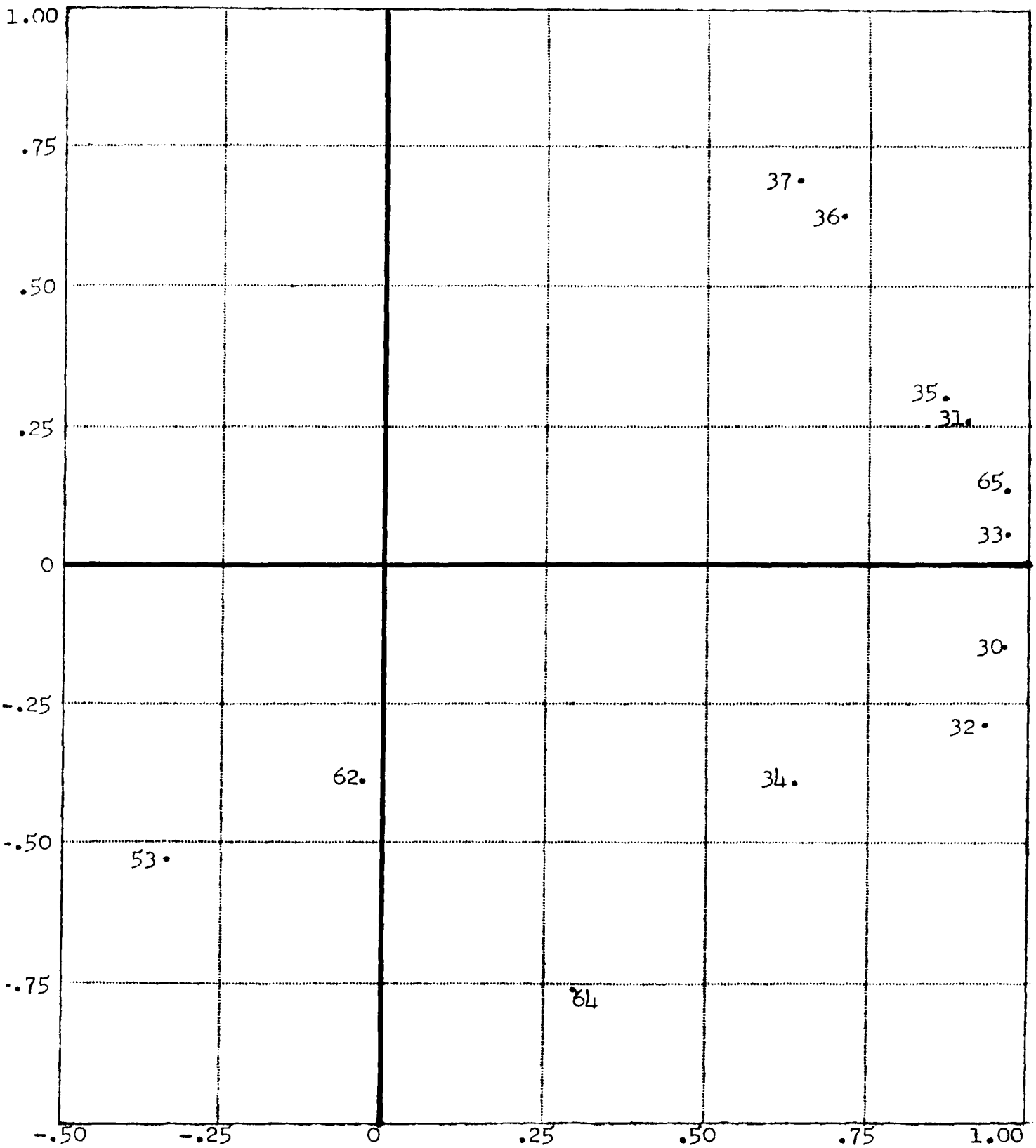
had positive loadings and the industrial activity factor (represented by #64) had a negative loading. However, there was not enough information in this analysis to identify this second factor. The use of the rotated matrix in this case did not simplify the factor structure but made it more obscure.

Analysis II 1929-1941

There were two factors determined in this analysis. However, the factor structure was very indeterminate. The overall structure was similar to that in Analysis I, but the structure was more scattered in appearance without any definite factor clusters. A diagram of the orthogonal structure is given in Figure 11.

A comparison of Figure 10 and Figure 11 shows that, whereas variables 33, 65, 32, 30 can be considered a factor cluster in Figure 10 they are more widespread in Figure 11, without any definite indication of where the factor plane should be located. It could be hypothesized that one of these factors was the general price level factor (along the horizontal) while the second factor (vertical) was such that marketing margins had positive factor loadings on it and the industrial activity factor (represented by #64) had a negative loading upon it. There was not enough information in this analysis to determine what this second factor was.

Figure 11. Orthogonal Factor Structure of Marketing Margins, Analysis II, 1929-1941.



V. SUMMARY OF RESULTS OF ANALYSES OF ECONOMIC DATA

This study had two main objectives. The first objective was to analyze economic data concerning economic conditions in general, and dairy products in particular, by means of multiple factor analysis in order to investigate what factors were operative during the two time periods of 1929-1948 and 1929-1941. The second objective was to determine how well these factors could explain and predict the disappearance of various dairy products, by setting up multiple regression systems based on the factor analyses.

In order to investigate what factors were operative during the two time periods under consideration in this study, the variables were grouped in several different ways. One group combined all variables relating to general economic conditions while other groups covered prices, fluid milk and cream, butter, cheese, condensed, dry and evaporated milk, the production and disappearance of dairy products, and marketing margins.

Results of Factor Structures

The analysis of General Economic Conditions produced two factors, a general price level factor and an industrial activity factor. These two factors were evident in both time periods, and explained most of the variations occurring in the variables included in the group. The appearance of these two factors indicated that they were not independent;

however, industrial activity and the general price level were more nearly independent during 1929-1941 than during 1929-1948. The general price level factor primarily influenced such variables as the consumer price index and the retail food price index, while the industrial activity factor influenced such variables as real purchasing power in manufacturing industries, the index of employment in manufacturing industries, and the index of industrial production.

In the analysis of Prices three factors were evident over the longer period of time. These were the general price level factor and industrial activity factor derived in the analysis of general economic conditions and a feed factor which influenced only two variables, the butterfat-feed price ratio and the milk-feed price ratio. The general price level factor influenced variables of both wholesale and retail prices, showing that these wholesale and retail prices followed the same general trend during this period. The industrial activity factor was associated primarily with real wholesale prices, showing that these real wholesale prices followed the trend of industrial activity and were relatively independent of the actual wholesale and retail prices. The factor structure also showed that the real retail prices did not follow the real wholesale prices, but were influenced by other factors as well. The factor structure for Prices in the period 1929-1941 was less well defined than that in the longer period of time. The general price

level factor was fairly well defined, and the feed factor was also well defined. Three other factors were determined in this analysis but the factor structure made it difficult to identify them satisfactorily.

The analysis of Fluid Milk and Cream determined four factors in the longer period of time. These were a general price level factor, an industrial activity factor, a milk production factor, and a real wholesale dry skim milk price factor. The factor structure indicated that most of the prices related to fluid milk and cream followed the trend of the factors of general economic conditions. Milk production on farms followed a seasonal trend, and the monthly disappearance of fluid milk and cream also followed this seasonal pattern. This might have been due to a weakness in the basic data, however, as the fluid milk and cream disappearance was computed as a residual from total production. The fact that the real wholesale price of skim milk and the real wholesale price of milk appeared as a separate real wholesale price factor indicated that these real wholesale prices were distinctive during this period and did not follow the trend of other prices.

During the period 1929-1941 the analysis of Fluid Milk and Cream showed the same factors as were evident during the period 1929-1948. However, one further factor was evident: a retail milk price factor. The factor structure indicated that the retail price of delivered milk was relatively

independent of the other variables in the analysis; it did not follow the trend of the general price level or industrial activity. It was also relatively independent of the milk production factor, showing that the retail price of milk was not associated with milk production.

The analysis of Butter showed four distinct factors. These were a general price level factor, a butter production factor, the feed factor discussed previously, and a real retail oleomargarine price factor. The general price level factor involved the wholesale and retail prices of butter and butterfat, the butter production factor followed the seasonal trend of milk production, the feed factor showed that the butterfat-feed price ratio was independent of the other variables in this analysis, and the real retail oleomargarine price factor indicated that this real retail price of oleomargarine was independent of the other prices and the other factors included in this analysis.

The analysis of Cheese showed five factors. These were a general price level factor, a cheese production factor, a real wholesale milk price factor, the feed factor discussed previously, and a real wholesale cheese price factor. The real wholesale cheese price factor was independent of the other factors, including the real wholesale milk price factor, during the longer period of time while the real wholesale cheese price factor and the real milk price factor were merged as one factor during the shorter period of time. This

indicated that the real wholesale price of cheese followed the same trend as the real wholesale milk and butterfat prices during 1929-1941 but during 1929-1948 the real wholesale cheese price followed a different trend from that of the real wholesale price of milk. This was probably due to the fact that during the shorter period of time the real wholesale price of cheese helped determine the real price of butterfat, while in the longer period other products became of increasing importance and the real wholesale price of butterfat and the real wholesale price of milk reflected these changes. Cheese disappearance followed the trend of cheese production, and appeared to be independent of all other factors in this analysis.

There were four factors present in the analysis of Condensed, Dry and Evaporated Milk. These were a general price level factor, an industrial activity factor, a milk production factor, and a real evaporated milk price factor. The real wholesale price of dry skim milk appeared as a separate factor during the period 1929-1941 but merged into the factor structure as a part of the industrial activity factor during the period 1929-1948. Thus, although the real wholesale price of dry skim milk appeared to follow an independent trend during the shorter period of time, it followed the general trend of industrial activity over the complete period 1929-1948. The real price of evaporated milk followed an independent trend in both time periods.

Three factors were evident in the analysis of

Production and Disappearance of Dairy Products. This analysis grouped together all of the variables of production and disappearance and also included variables representing the factors of general economic conditions. The analysis showed that, although the general price level factor and the industrial activity factor were operative in the production and disappearance of dairy products, other factors were also influential in the analysis. The only factor which was clearly identified was a production factor which was evident in the production of cheese, evaporated milk, fluid milk and cream, and dried or powdered skim milk. This production factor was not evident in the production of butter. There was no general pattern in the disappearance of dairy products, although the general price level factor and the industrial activity factor were of some importance.

In the analysis of marketing margins alone the factor structure showed that a general price level factor primarily influenced the marketing margins on dairy products as a whole and the fluid milk marketing margin, but that some other factor was also influential in the marketing margins of butter, American cheese, and evaporated milk. There was not enough information available to identify this other factor, although there were some indications that it was associated with an industrial activity factor. This factor structure was not very well defined.

Relationships within factor structures

Some of the relationships existing within the factor structures may be described as follows:

a. Two separate factors were evident in variables indicating general economic conditions. These were a general price level factor and an industrial activity factor.

b. The general price level factor was represented best by the Consumer Price Index and the Index of Retail Food Prices. It did not matter whether these variables were used directly or advanced through time by a one month or two month interval.

c. The industrial activity factor was represented best by the Index of Real Purchasing Power, the Index of Employment in Manufacturing Industries, and the Index of Industrial Production. It did not matter whether these variables were used directly or advanced through time by a one month or two month interval.

d. The Index of Department Store Sales was not a good indicator of general economic conditions as it varied through time. It was influenced primarily by the general price level factor in 1929-1948 while it was influenced more by the industrial activity factor during 1929-1941. Likewise the Index of Freight Car Loadings and the Index of Short Term Consumer Debt were not good indicators of general economic conditions.

e. Wholesale and retail prices of most dairy products were

influenced primarily by the general price level factor in the two time periods under consideration here. Although unique factors might have also influenced these variables, a large part of the variations in these price variables was explained by the general price level factor alone.

f. The marketing margin on fluid milk and cream was influenced primarily by the general price level factor. Thus as the general price level increased the marketing margin on fluid milk and cream increased.

g. The marketing margin for all dairy products was also influenced primarily by the general price level factor. This indicated that the marketing margin on fluid milk and cream was the most important product in the combined marketing margin of all dairy products, since the marketing margins for other products were influenced by a second factor as well.

h. The marketing margins for butter, American cheese, and evaporated milk were shown to be influenced directly by the general price level factor and inversely by the industrial activity factor. Thus as the general price level increased, marketing margins increased. As industrial activity increased, marketing margins decreased. If both the general price level and industrial activity increased, the net effect on these marketing margins would have to be considered.

i. A feed factor, involving the butterfat-feed price ratio

and the milk-feed price ratio, was independent of all other factors in these analyses. This indicated that these variables were not associated with the other variables in this study and that these feed ratios did not affect the dairy product prices, the other prices, or the production of the dairy products included herein.

j. In general, there were three factors which appeared fairly consistently in the analyses of individual commodities. These were a general price level factor, which involved most of the wholesale and retail prices included in this study, an industrial activity factor, which involved many real wholesale and real retail prices, and a production factor, which showed the seasonal nature of most manufactured dairy products corresponding to the seasonal trend of milk production. In a few cases a real wholesale price factor was evident which was different from the industrial activity factor. These factors explained the variations occurring in the price and production variables included in this study fairly well, but the disappearance variables were not explained as fully as the other variables.

k. The variable of Fluid Milk and Cream Disappearance appeared to follow the trend of seasonal milk production. This may have been due to the fact that the disappearance was computed as a residual from the total milk production. A more accurate method of measuring this disappearance would probably make a difference in the factor structure

obtained.

l. The variable showing cheese disappearance was influenced to a large extent by the cheese production factor. This indicated that cheese disappearance depended largely upon cheese production and that other factors, such as the general price level factor, were not of major importance in the demand for cheese. This signified an inelastic demand for cheese.

m. Butter disappearance was associated primarily with the general price level factor. As the general price level increased, butter disappearance decreased. This result may have been due to the shifting demand for butter during the period 1929-1948, however.

n. The disappearance of evaporated milk appeared to have an indeterminate structure during the two time periods under consideration. This, again, may have been due to the changing demand for evaporated milk during these periods.

Results of Multiple Regression Systems

To determine how well the factors discussed above could estimate and predict demand for the individual dairy products, multiple regression systems were set up based on the factor analyses. In each multiple regression system the disappearance, as an indicator of demand, was the dependent variable while the independent variables were selected on the basis of the factor structures. The number of independent

variables was determined by the number of distinct factors in the factor structure; one variable was selected to represent each factor in the regression systems. These systems were then extrapolated to cover 1949 and part of 1950, to see how well the estimated disappearance compared with the actual disappearance.

The multiple regression system for fluid milk and cream for the period 1929-1948 yielded a coefficient of multiple correlation of r = .8642. This system included as independent variables the consumer price index, real purchasing power, milk production on farms, and the real wholesale price of milk, and the coefficients of these variables in the regression equation all proved to be significant. The regression system for the period 1929-1941 yielded a coefficient of multiple correlation of r = .8768. The independent variables in this analysis were the consumer price index, real purchasing power, milk production on farms, and the retail price of delivered milk. In this system the coefficient for real purchasing power proved to be not significant. The coefficients of all the other variables were significant, however.

The estimated disappearance of fluid milk and cream as computed from the regression system of the period 1929-1948 was very close to the actual disappearance, while the estimated disappearance from the regression system of the period 1929-1941 was far below the actual disappearance. This signifies that an increase in demand took place in fluid

milk and cream during these two time periods.

The multiple regression system for butter disappearance for the period 1929-1948 yielded a coefficient of multiple correlation of r = .7727. The independent variables in this system were the consumer price index, real purchasing power, butter production, real retail price of oleomargarine, and the butterfat-feed price ratio. The coefficients of the last two variables proved to be not significant in the regression equation, but the coefficients of the remaining three were highly significant in the system. The coefficient of multiple correlation for the period 1929-1941 was r = .5120. In this system the consumer price index, real purchasing power, butter production, and the real retail price of oleomargarine were used as the independent variables. Only the coefficients of butter production and the real retail oleomargarine price proved significant in the regression equation.

The estimated butter disappearance for 1949 from the regression equation covering the period 1929-1948 was somewhat lower than the actual disappearance. The estimated disappearance from the regression equation covering the period 1929-1941 was much higher than the actual disappearance. This indicates the decrease in the demand for butter during these two time periods.

The multiple regression system for cheese disappearance for the period 1929-1948 yielded a coefficient of multiple correlation of r = .7603. The independent variables in this system were the consumer price index, cheese production, real

purchasing power, butterfat-feed price ratio, and the real wholesale price of cheese. The latter two variables proved to be not significant in the regression equation. The regression system covering the period 1929-1941 yielded a coefficient of multiple correlation of r = .7602. This system contained the consumer price index, cheese production, the butterfat-feed price ratio and the real wholesale price of cheese as independent variables. However, only the coefficient of cheese production proved to be significant in the regression equation.

The estimated cheese disappearance for 1949 from both of these regression systems was below the actual cheese disappearance in 1949. However, the regression systems indicate that there was an increase in the demand for cheese during these two periods.

The multiple regression system for evaporated milk disappearance during the period 1929-1948 yielded a coefficient of multiple correlation of r = .6342. The independent variables in this system were the consumer price index, real purchasing power, milk production on farms, and the real wholesale evaporated milk price. In the regression equation the coefficient of the consumer price index was not significant, but the coefficients of all the other variables were significant. The regression system covering the period 1929-1941 yielded a coefficient of multiple correlation of r = .7150. The consumer price index, real purchasing power, milk production on farms, the real wholesale dry skim milk

price, and the real wholesale price of evaporated milk were the independent variables. The latter two variables proved to be not significant in the regression equation.

The estimated disappearance for 1949 as computed by both regression systems was below the actual disappearance in 1949. However, these regression systems indicated that there was an increase in the demand for evaporated milk during these two time periods.

In all of the regression systems discussed above, the consumer price index was used to represent the general price level factor. To investigate what changes would occur if the actual retail prices of the individual products were used in place of the consumer price index, these retail prices were substituted in the regression systems in the place of the consumer price index and the multiple regression coefficients recomputed. The coefficients were practically the same in all cases. This indicated that it did not matter whether the consumer price index or the retail price of the individual commodity was used in the regression equation. It also indicated that the selection of one variable from a factor cluster to represent the factor in a regression system was valid and that the substitution of one variable for another from the same factor cluster could yield essentially the same results. This might not have been true if other variables were selected from the factor cluster, however.

VI. SUMMARY AND EVALUATION OF THE METHOD OF FACTOR ANALYSIS AS APPLIED TO ECONOMIC DATA

This study showed that the method of factor analysis could be applied to economic data to provide logical, consistent results. A great deal is known about general economic conditions and about dairy products; the usefulness of this study was to demonstrate that results could be obtained from factor analyses which were consistent with and which corroborated previous knowledge. The derivation of a general price level factor and an industrial activity factor from the analysis of general economic conditions, and the derivation of a production factor and a price factor in almost all of the analyses of individual dairy products were results which would have been expected. These findings might help to provide confidence in results from studies where less background information would be available.

It should be emphasized, however, that many serious weaknesses appeared in the application of factor analysis to the economic data in this study. In several cases factor structures were obtained which could not be identified. This was especially true in the analysis of Prices for the period 1929-1941, the analyses of Production and Disappearance of Dairy Products for the two time periods considered here, and the analyses of Marketing Margins for the two time periods. In these cases, specific factors were obtained but there was not enough information to identify the factors

satisfactorily. This might have been due to the selection of variables for the analyses, since additional variables or a different choice of variables might have provided a better factor structure. The selection of different time periods might also have provided better results.

Some conflicting results were obtained between the different factor analyses made in this study. For example, the real wholesale price of evaporated milk appeared to be part of the general price level factor in Analysis I of Prices, while it appeared as a separate factor in Analysis I of Condensed, Dry and Evaporated Milk. In Analysis II of Prices, the real wholesale price of butterfat appeared as a part of the general price level factor, while in Analysis II of Cheese it appeared as a part of a real wholesale cheese price factor. These conflicts might have been due to the different factors which were derived in these analyses or were perhaps due to the non-orthogonal factor structures where the angular separation between factors changed in each analysis. It should be noted, however, that most of the variables showed consistent relationships between analyses.

It was stated previously that these factor analyses provided results consistent with previous knowledge. In some cases, however, the factor analyses conflicted with previous knowledge. In the analyses of Fluid Milk and Cream, milk disappearance appeared to follow the seasonal trend of milk production, even though it is generally accepted that there is no seasonal trend in milk disappearance. This

probably indicates the inadequacy of the data used for milk disappearance. In the analysis of Production and Disappearance of Dairy Products, the variable of ice cream production showed an indeterminate structure, although it is generally accepted that ice cream production follows the seasonal trend of milk production. This difference may have come about due to the rotation process from the orthogonal factor structure. It may also have been due to the coding of the data necessary for the I.B.M. process, as this coding might have covered up some of the seasonal changes which took place.

There were thus several possible causes for the weaknesses of multiple factor analysis as applied to the economic data in this study. Some of these were the selection of variables to be included in the analyses, the selection of the time periods to be used, the accuracy of the basic data, the non-orthogonal factor structures used, and the I.B.M. coding which might have covered up essential imformation.

Another inherent weakness of multiple factor analysis is that the analysis is based on simple correlations. The use of these simple correlations with data containing seasonal, cyclical, and random fluctuations is a serious drawback. The use of correlations with time series data also involves auto-correlations within the data. This study showed that the same factors could be derived from time series data even though different time periods were used.

This was not true in all cases, however.

Factor analyses as such cannot be used for estimation or prediction purposes. In this study multiple regression systems based on the factor analyses were used to estimate the disappearance of fluid milk, butter, cheese, and evaporated milk. In these regression systems, the best coefficient of multiple correlation obtained was r = .88, while the poorest obtained was r = .51. Thus the explained variance in dairy product disappearance varied from approximately 75 percent to 25 percent. This difference in the explained variance might have been due to the time periods used, the variables used in the factor analyses, or the accuracy of the basic data used. The disappearance data for the dairy products were explained fairly well by the factor structures and the regression systems in approximately 50 percent of the cases tested.

If this study were to be repeated, several changes might be suggested. First, the form of some of the data might be changed. It would be desirable to put the production and disappearance data on a per capita basis, to investigate whether or not better estimates of demand might be obtained by this revision. Some of the data could be corrected for seasonal trends, in order to eliminate some of the fluctuations in the data which might cause inconsistent results. It would be desirable to use the actual data, rather than coded data in obtaining the correlation coeffi-

cients used in this work, although this would be an expensive and time-consuming operation which might not provide enough significant differences from coded I.B.M. tabulations to be worthwhile.

Additional data might also be included for further study. Data such as disposable income, monthly expenditures for individual dairy products, and total employment, price ratios between commodities such as butter and oleomargarine, cheese and meat, cheese and eggs, and fluid milk and evaporated milk, and disappearance data for products such as meat, eggs, and cereals, might be included in an attempt to get more determinate results concerning demand relationships. Several variables might be advanced through time to investigate what effects they would have on the factor structures. Specifically, various feed price ratios might be advanced through time six months to a year, or beef or hog prices might be advanced six months to eighteen months, to investigate what effects they might have on dairy production, prices, or disappearance. Different time periods might be used, such as the periods 1929-1939, 1941-1951, or 1946-1951, to investigate whether factors were operative during these periods which differed from those which were determined in the analyses of the time periods of 1929-1948 and 1929-1941. Different combinations of the variables might also be used, to attempt to obtain more determinate factor structures.

This study investigated the various factors which

existed during the time periods of 1929-1948 and 1929-1941. However, little or no attempt was made to analyze why these factors existed or what made them distinct from other factors. For example, a general price level factor was determined in several analyses. This factor was probably influenced by the amount of money in circulation, monetary and fiscal policies in operation, political events on both a national and international level, expectations concerning future developments, and demand and supply relationships existing between different commodities. Similarly, any other factor, such as a real wholesale cheese price factor or a milk production factor, would probably be determined by many distinct elements which might or might not be measurable. This study only attempted to isolate the various factors which existed in the data. With the original 76 variables grouped into essentially seven or eight distinct factors, a more exhaustive study might be made on these factors to determine what made them distinct.

Factor analysis is useful as a first approximation for a large mass of data which has not been thoroughly investigated or about which not very much is known. It provides a rough method of sorting a large body of data into groups which contain similar elements. It cannot be used to provide exact information or precise measurements. This study has shown that factor analysis can be applied to economic data to provide determinate factor structures in some cases. The factor analyses could not be used to estimate demand but

regression systems based on the factor analyses have been used to estimate the disappearance of various dairy products. The results of these regression systems indicate that the factor structures provided a satisfactory basis for the estimation of demand in some cases, while in other cases they were very unsatisfactory.

In conclusion, it is felt that factor analysis should prove to be a useful tool in empirical economic analysis to provide a first approximation for unexplored data. Further study is necessary before its value in the estimation of demand relationships can be properly evaluated.

VII. APPENDIX A

ORTHOGONAL AND ROTATED FACTOR STRUCTURES

Analysis I GENERAL ECONOMIC CONDITIONS

Orthogonal Factor Matrix, giving factor loadings and communalities

Variables No.	Factors I	II	Communalities
51	.959	.000	.978
52	.965	-.0[illegible]	.[illegible]73
2[illegible]	.971	.039	.944
5[illegible]	.972	.05[illegible]	.952
5[illegible]	.[illegible]7[illegible]	.[illegible]	.[illegible]75
5[illegible]	.873	.[illegible]18	.[illegible]69
8[illegible]	.959	.011	.9[illegible]2
81	.899	-.333	.919
[illegible]	.[illegible]53	.0[illegible]	.[illegible]
[illegible]	.[illegible]	.[illegible]	.[illegible]60
[illegible]	.[illegible]	-.[illegible]	.931
[illegible]	.[illegible]71	.735	.[illegible]88
[illegible]	.[illegible]34	.[illegible]	.[illegible]7[illegible]
[illegible]	.737	.657	.[illegible]7[illegible]
[illegible]	.[illegible]87	-.0[illegible]	.[illegible]
[illegible]	.[illegible]	-.[illegible]	.[illegible]73
[illegible]	.[illegible]77	.[illegible]	.[illegible]
[illegible]	.[illegible]	.[illegible]	.[illegible]51
[illegible]	.980	-.011	.976
[illegible]	.[illegible]	-.[illegible]	.[illegible]
[illegible]	-.158	.014	.025
[illegible]9	.[illegible]78	.[illegible]	.[illegible]3[illegible]
7[illegible]	.[illegible]94	.352	.[illegible]
[illegible]6	.[illegible]	-.[illegible]	.[illegible]7[illegible]
[illegible]9	.[illegible]71	.[illegible]23	.[illegible]73

Analysis : **GENERAL ECONOMIC CONDITIONS**

[illegible] living related [illegible]
[illegible] angles between factors.

Variable no.	Factors I	II
1	.726	.038
2	.711	.005
3	.190	.0[illegible]
4	.858	.111
5	.079	.[illegible]90
6	.263	.[illegible]63
7	.697	.071
8	.[illegible]06	-.[illegible]30
9	.[illegible]52	.[illegible]02
10	.[illegible]38	.273
11	-.085	-.[illegible]50
12	-.005	.[illegible]53
13	.086	.[illegible]66
14	.095	.[illegible]79
15	.[illegible]58	-.[illegible]15
16	.[illegible]90	-.[illegible]25
17	.203	.[illegible]47
18	.[illegible]53	.[illegible]32
19	.[illegible]33	.[illegible]79
20	.737	.[illegible]09
21	-.[illegible]35	.[illegible]09
22	.341	.[illegible]45
23	.270	.373
24	.[illegible]12	-.[illegible]14
25	.[illegible]99	.[illegible]13

Cosines of Angles between Factors

1.000
-.760 1.001

Table 14. GENERAL ECONOMIC CONDITIONS
[illegible] million.

[illegible]	[illegible]	[illegible]	[illegible]
24	.5[illegible]	-.0[illegible]	.9[illegible]
[illegible]	.7[illegible]	-.0[illegible]	.9[illegible]
[illegible]	.906	.26[illegible]	.95[illegible]
[illegible]	.8[illegible]	.3[illegible]	.96[illegible]
8[illegible]	.4[illegible]	.[illegible]93	.97[illegible]
[illegible]	.93[illegible]	.830	.95[illegible]
[illegible]	.97[illegible]	-.001	.95[illegible]
[illegible]	.[illegible]8[illegible]	-.3[illegible]	.92[illegible]
[illegible]	-.[illegible]72	.[illegible]03	.82[illegible]
[illegible]	.3[illegible]	.[illegible]6[illegible]3	.333
[illegible]	.02[illegible]	.05[illegible]	.003
[illegible]	.[illegible]0[illegible]	.9[illegible]0	.97[illegible]
[illegible]	.[illegible]	.[illegible]78	.97[illegible]
[illegible]	.[illegible]7[illegible]	.8[illegible]	.95[illegible]
[illegible]1	.9[illegible]6	-.0[illegible]	.9[illegible]
[illegible]	.9[illegible]	-.0[illegible]	.9[illegible]7
[illegible]	.[illegible]9[illegible]	.9[illegible]	.97[illegible]
[illegible]	.[illegible]9[illegible]	.9[illegible]	.96[illegible]
[illegible]	.[illegible]0[illegible]	-.1[illegible]	.89[illegible]
[illegible]	.92[illegible]	-.1[illegible]	.[illegible]
[illegible]	.022	.[illegible]0[illegible]	.01[illegible]
[illegible]	-.3[illegible]1	.85[illegible]	.87[illegible]
[illegible]	.[illegible]2[illegible]	.3[illegible]2	.80[illegible]
[illegible]	.[illegible]7[illegible]	.75[illegible]	.75[illegible]
[illegible]	.[illegible]79	.9[illegible]0	.95[illegible]

Table XVa Analysis II GENERAL ECONOMIC CONDITIONS
[illegible] rotated matrix, [illegible] rotated factor loadings and [illegible] of varimax normalized factors.

Variable No.	Factor I	Factor II
21	.[illegible]	.[illegible]
22	.[illegible]	.[illegible]
23	.[illegible]	.[illegible]
24	.[illegible]	.[illegible]
25	.[illegible]	.[illegible]
26	.[illegible]	.[illegible]
27	.[illegible]	.[illegible]
28	.[illegible]	-.[illegible]
29	-.[illegible]	.[illegible]
30	.131	.[illegible]
31	.[illegible]	.[illegible]
32	-.[illegible]	.[illegible]
33	.[illegible]	.[illegible]
34	.[illegible]	.[illegible]
35	.[illegible]	.[illegible]
36	.[illegible]	.[illegible]
37	.[illegible]	-.[illegible]
38	-.[illegible]	.[illegible]
39	-.[illegible]	.[illegible]
65	.912	-.011
66	.917	-.[illegible]
67	-.[illegible]	.[illegible]
69	-.[illegible]	.[illegible]
77	.[illegible]	.[illegible]
78	.130	.[illegible]
79	-.012	.937

Cosines of Angles between Factors

1.000	
-.315	1.000

Table V

Analysis I Males

Orthogonal Factor Matrix, giving factor loadings and communalities.

Variables No.	Factors I	II	III	Communality
9	.950	.017	.216	.949
10	.938	.122	.235	.950
11	.079	.900	-.074	.822
12	.136	.900	.073	.831
13	.989	.000	.000	.978
14	.969	.000	.000	.939
15	.977	.000	.000	.955
16	.956	.000	.000	.914
17	.971	.000	.000	.943
18	.987	.000	.000	.975
19	.965	.000	.000	.931
20	.993	.000	.000	.986
21	.977	.000	.000	.955
22	.915	.000	.000	.839
23	.919	-.106	-.233	.910
24	.985	.000	.000	.970
25	.966	.000	.000	.933
26	.938	.000	.000	.879
27	.905	-.206	-.696	.[illegible]
28	.679	-.261	-.473	.753
29	.807	-.183	-.376	.543
30	.954	.063	.226	.964
31	.902	.178	.497	.922
32	.[illegible]	.339	.270	.[illegible]
33	.[illegible]	.332	.[illegible]	.707
34	.603	.333	.078	.481
35	-.300	.422	.359	.397
36	-.740	.194	.009	.585
37	-.600	.189	.015	.396
38	.504	-.006	-.521	.[illegible]
39	.640	.222	-.127	.475
40	.445	-.056	-.366	.335
41	-.297	.367	-.045	.228
42	.685	.378	.603	.742
43	.964	.322	.745	.728
44	.807	.383	.559	.828
45	.956	.461	.619	.902
46	.798	.183	.571	.890
47	.970	.000	.000	.943
48	-.161	.128	-.028	.043
49	.728	.083	.303	.629
50	-.063	-.472	.115	.[illegible]

Table VIa Analysis 1 Males

Rotated Matrix, giving rotated factor loadings and cosines of angles between factors.

Variable No.	Factors I	II	III
9	.505	-.070	.216
10	.471	.018	.235
11	.029	.851	-.074
12	-.036	.796	.073
13	.688	.000	.000
14	.673	.000	.000
15	.679	.000	.000
16	.669	.000	.000
17	.675	.000	.000
18	.686	.000	.000
19	.670	.000	.000
20	.694	.000	.000
21	.679	.000	.000
22	.638	.000	.000
23	.815	-.004	-.233
24	.685	.000	.000
25	.670	.000	.000
26	.560	.000	.000
27	.936	.068	-.696
28	.833	-.051	-.696
29	.707	-.017	-.376
30	.502	-.010	.216
31	.186	-.035	.497
32	.277	.203	.270
33	.259	.192	.290
34	.334	.276	.078
35	-.502	.243	.359
36	-.537	.174	.009
37	-.305	.367	.015
38	.751	.202	-.521
39	.516	.254	-.127
40	.575	.095	-.366
41	-.206	.354	-.045
42	-.126	.106	.603
43	-.376	-.002	.745
44	-.010	.128	.559
45	-.096	.175	.619
46	.083	-.060	.571
47	.674	.000	.000
48	-.103	.129	-.028
49	.282	-.045	.303
50	-.101	-.491	.145

Cosines of Angles between Factors

1.000		
.205	1.002	
-.714	-.399	1.000

Analysis II

Orthogonal Factor matrix, giving factor loadings and communalities.

Variable No.	I	II	III	IV	V	Communality
9	.973	.000	-.104	.000	.000	.958
10	.963	.047	-.042	.000	.000	.931
11	.306	.874	.042	.000	.000	.859
12	.159	.913	-.041	.000	.000	.859
13	.909	-.062	.192	.000	.000	.867
14	.975	-.012	-.125	.000	.000	.966
15	.933	.027	-.163	.000	.000	.905
16	.948	.023	-.154	.000	.000	.923
17	.960	.020	-.039	.000	.000	.924
18	.932	-.034	.159	.000	.000	.895
19	.886	.028	.208	.357	-.120	.971
20	.847	-.107	.471	.000	.000	.949
21	.885	-.095	.423	.000	.000	.971
22	.951	.006	.067	.000	.000	.912
23	.800	-.096	.477	.000	.000	.877
32	.952	-.022	.194	.000	.000	.944
33	.824	-.017	.507	.000	.000	.936
34	.687	.080	.068	.625	-.095	.869
35	.601	-.033	.793	.000	.000	.843
36	.311	-.210	.908	.000	.000	.965
37	.254	-.105	.903	.000	.000	.891
40	.659	-.026	.402	.000	.000	.900
41	.773	-.110	-.324	.000	.000	.715
43	.593	.315	-.407	.130	.339	.770
44	.681	.295	-.438	.099	.270	.825
45	.742	.312	-.279	-.133	.209	.787
46	-.057	.351	.066	.448	.619	.715
47	-.394	.366	-.419	.585	.212	.852
48	-.174	.179	.326	-.017	.717	.683
49	.530	.182	.412	-.185	.499	.767
50	.772	.237	-.339	-.254	.153	.855
51	.514	-.015	.504	-.159	-.105	.555
52	.035	.440	-.599	.357	.371	.819
54	.319	.243	.567	.022	.616	.862
55	.375	.021	-.505	.138	.431	.601
56	.812	.180	-.267	.000	.000	.813
57	.677	.374	-.208	.275	.239	.774
64	.620	.069	-.490	.538	-.040	.920
65	.786	.015	.[illegible]	.000	.000	.960
67	.079	.233	-.114	-.039	-.070	.079
69	-.081	.111	-.784	.585	-.078	.982
72	-.175	-.404	.162	.202	.036	.321

[illegible] Analysis II [illegible]

Rotated matrix, giving varimax factor loadings and cosines of angles between factors.

Variable No.	I	II	III	IV	V
[illegible]	.283	.005	.167	.000	.000
20	.751	.017	.139	.000	.000
31	.077	.624	-.016	.000	.000
12	-.109	.8[illegible]	.013	.000	.000
33	.077	-.067	-.012	.000	.000
34	.777	-.006	.189	.000	.000
35	.707	-.036	.211	.000	.000
36	.733	.029	.195	.000	.000
[illegible]	.[illegible]	.[illegible]	.126	.000	.000
38	.875	-.039	.009	.000	.000
39	.332	-.007	-.036	.357	-.069
40	.963	-.122	-.184	.000	.000
41	.970	-.109	-.151	.000	.000
42	.049	.002	.053	.000	.000
[illegible]	.[illegible]	-.113	-.193	.000	.000
45	.905	-.030	-.010	.000	.000
[illegible]	.93[illegible]	-.039	-.210	.000	.000
[illegible]	.[illegible]	.001	.109	.[illegible]	-.009
[illegible]	.836	-.06[illegible]	-.345	.000	.000
3[illegible]	.[illegible]	-.[illegible]	-.500	.000	.000
[illegible]	.[illegible]	-.141	-.506	.000	.000
53	.[illegible]	-.[illegible]	-.1[illegible]	.000	.000
[illegible]	.[illegible]	-.089	.281	.000	.000
[illegible]	.7[illegible]	.[illegible]	.582	.120	.352
[illegible]	.33[illegible]	.20[illegible]	.[illegible]	.099	.261
[illegible]	.452	.271	.366	-.133	.188
[illegible]	-.042	.064	.519	.[illegible]	.675
[illegible]	-.593	.21[illegible]	.492	.585	.291
68	.028	-.044	.323	-.017	.707
[illegible]	.[illegible]	.043	.1[illegible]	-.1[illegible]	.[illegible]
[illegible]	.[illegible]	.236	.337	-.25[illegible]	.116
[illegible]	.[illegible]	.018	-.[illegible]	-.159	-.12[illegible]
[illegible]	-.311	.263	.712	.357	.[illegible]17
[illegible]	.[illegible]	.026	.16[illegible]	.022	.013
[illegible]	.127	-.100	.701	.13[illegible]	.[illegible]
[illegible]	.[illegible]	.182	.2[illegible]	.000	.000
[illegible]	.[illegible]	.253	.[illegible]	.275	.275
[illegible]	.[illegible]	.012	.[illegible]	.536	.035
[illegible]	.933	-.019	-.262	.000	.000
[illegible]	-.[illegible]	.[illegible]	.[illegible]	-.[illegible]	-.075
[illegible]	-.[illegible]	.009	.530	.535	.004
72	.017	-.[illegible]	-.039	.202	.[illegible]

Table IXA — Analysis I FLUID MILK AND CREAM

Orthogonal Factor Matrix, Six-Cor Factor Loadings and Communalities.

Variable No.	Factors I	II	III	Communality
1	.715	-.500	.046	.812
10	.928	.000	.213	.959
11	.110	.137	.516	.600
12	.960	.000	.000	.972
13	.970	.000	.000	.941
15	.972	.000	.000	.945
16	.822	-.107	.367	.694
17	.902	.000	.000	.945
[illegible]	.[illegible]	.[illegible]	.[illegible]	.929
20	.945	.000	.000	.895
[illegible]	.870	.013	.167	.786
40	.973	-.051	.193	.946
41	.807	-.052	.619	1.037
47	-.777	.130	.190	.[illegible]
[illegible]	.[illegible]	-.[illegible]	.010	.[illegible]
[illegible]	.560	.133	.783	.833
[illegible]	-.[illegible]	.[illegible]	.062	.[illegible]
69	.[illegible]	-.[illegible]	.[illegible]	.[illegible]
[illegible]	-.[illegible]	-.131	-.394	.732
	.476	-.[illegible]	.120	.856

[illegible] [illegible]

rotated matrix, giving rotated factor loadings and cosines of angles between factors.

Variable No.	Factors I	II	III
1	.919	-.[illegible]	-.070
10	.928	.040	.266
15	-.015	.537	.570
[illegible]	.939	.000	.000
[illegible]	.923	.000	.000
[illegible]	.925	.000	.000
[illegible]	.725	-.307	.330
32	.934	.000	.000
33	.926	.000	.000
[illegible]	.000	.000	.000
[illegible]	.777	.053	.217
40	.648	-.0[illegible]	.381
42	.579	-.0[illegible]	.[illegible]
[illegible]	-.750	.130	.206
[illegible]	.012	-.078	.799
[illegible]	.307	.133	.754
[illegible]	-.1[illegible]	.000	.103
49	.595	-.1[illegible]	.[illegible]
[illegible]	.003	-.831	-.300
[illegible]	.009	-.780	.040

Cosines of Angles between Factors

	I	II	III
I	.999		
II	.000	1.000	
III	-.302	.000	1.000

Table V. Analysis II [illegible]

Orthogonal Factor Matrix, giving factor loadings and communalities.

Variable No.	I	II	III	IV	V	VI	Communality
1	-.243	-.862	.071	.597	.060	-.029	1.168
[illegible]	.918	.196	.179	.000	.000	.000	.913
[illegible]	.133	.504	.301	.000	.000	.000	.364
[illegible]	.956	.000	.000	.000	.000	.000	.914
[illegible]	.917	.205	.164	-.597	.062	-.029	1.397
[illegible]	.939	-.109	-.238	.000	.000	.000	.941
[illegible]	.938	-.002	.714	.000	.000	.000	.917
[illegible]	.976	.000	.000	.000	.000	.000	.953
[illegible]	.923	-.273	-.116	.000	.000	.000	.914
[illegible]	.888	-.365	.539	.000	.000	.000	.882
[illegible]	.[illegible]	.[illegible]	.402	.097	.052	-.004	.[illegible]
[illegible]	.713	.000	.000	.000	.000	.000	.835
[illegible]	.[illegible]	.095	.[illegible]	.[illegible]	.016	.[illegible]	.998
[illegible]	-.437	.222	.732	.000	.000	.000	.776
[illegible]	.272	.169	.518	.164	.064	.685	.849
[illegible]	.[illegible]	.455	.[illegible]	.000	.000	.000	.838
[illegible]	.[illegible]	.[illegible]	.023	.[illegible]	.030	.003	.579
[illegible]	-.[illegible]	.206	.[illegible]	.000	.000	.000	.711
[illegible]	-.139	-.869	.013	-.151	-.[illegible]	-.020	.859
[illegible]	-.[illegible]	-.[illegible]	-.[illegible]	.000	.000	.000	.815

[illegible] Analysis II [illegible]

[illegible] matrix, giving rotated factor matrix and cosines of angles between factors.

Variable No.	Factors I	II	III	IV	V	VI
1	-.016	-.013	.016	.553	.062	-.029
10	.470	.130	.356	.000	.000	.000
12	-.195	.375	.264	.000	.000	.000
13	.044	.009	.000	.000	.000	.000
[illegible]	.[illegible]4	.190	.216	-.570	.063	-.029
[illegible]	.[illegible]8	-.048	-.169	.000	.000	.000
[illegible]	-.01[illegible]	-.184	.619	.000	.000	.000
[illegible]	.652	.000	.000	.000	.000	.000
[illegible]	.738	-.136	-.101	.000	.000	.000
[illegible]	.389	-.293	.479	.000	.000	.000
[illegible]	.092	-.17[illegible]	.341	-.[illegible]	.[illegible]1	-.001
[illegible]	.015	.000	.000	.000	.000	.000
[illegible]1	.513	.005	-.133	-.06[illegible]	-.032	.687
[illegible]2	-.799	.011	.634	.000	.000	.000
[illegible]5	.051	-.010	.097	-.03[illegible]	.01[illegible]	.685
[illegible]	.036	.264	.420	.000	.000	.000
[illegible]7	-.023	.007	-.001	.057	.[illegible]39	.003
[illegible]9	-.[illegible]32	-.014	.[illegible]50	.000	.000	.000
72	.052	-.693	.036	-.074	-.250	-.020
[illegible]	.049	-.753	-.074	.000	.000	.000

Cosines of Angles between Factors

	I	II	III	IV	V	VI
I	1.000					
II	-.017-	1.001				
III	-.71[illegible]	-.218	1.002			
IV	-.01[illegible]	.090	.021	1.001		
V	-.025	-.358	.034	-.232	1.000	
VI	.350	-.009	-.490	-.235	-.070	1.000

[illegible] analysis [illegible]

[illegible] Varimax rotated factor matrix, giving factor loadings And communalities

Variable No.	I	II	III	IV	Communality
2	-.440	-.734	.026	.000	.809
3	.877	.000	.000	.000	.769
9	.960	.000	.000	.000	.922
11	.083	.349	.047	.551	.457
14	.975	.000	.000	.000	.951
17	.974	.000	.000	.000	.949
22	.917	.000	.000	.000	.841
23	.904	-.073	-.379	.000	.966
25	.969	.000	.000	.000	.939
29	.878	-.000	.300	.000	.930
32	.961	.000	.000	.000	.924
33	.946	.000	.000	.000	.895
35	.579	-.012	-.405	-.218	.749
39	.877	.000	.000	.000	.769
40	.857	.178	-.175	.437	.685
41	.[illegible]	.002	-.552	.268	.609
46	.630	.139	.[illegible]	.[illegible]	.739
47	-.[illegible]	.577	.180	-.313	.466
[illegible]	.[illegible]	-.062	.[illegible]	.000	.903
[illegible]	-.[illegible]	-.[illegible]	-.027	.000	.683
73	-.[illegible]	-.[illegible]	-.[illegible]	-.111	.672

Table XIVa Analysis I BUTTER

Rotated Matrix, giving rotated factor loadings and cosines of angles between factors.

Variables No.	I	II	III	IV
2	.010	-.011	.028	.000
5	.611	.000	.000	.000
9	.669	.000	.000	.000
11	.005	.313	.047	.585
14	.679	.000	.000	.000
17	.629	.000	.000	.000
22	.638	.000	.000	.000
25	.430	-.117	-.379	.000
28	.675	.000	.000	.000
29	.806	-.013	.350	.000
32	.653	.000	.371	.000
33	.659	.000	.000	.000
36	.029	-.006	-.285	-.218
39	.011	.000	.000	.000
50	.317	-.030	-.175	.437
51	-.015	-.175	-.552	.268
56	.557	-.047	.322	.593
67	-.235	.073	.100	-.313
69	.695	.020	.576	.000
72	.244	-.256	-.027	.000
73	-.607	-.125	-.216	-.141

Cosines of Angles Between Factors

	I	II	III	IV
I	.998			
II	.299	1.000		
III	.600	.132	1.000	
IV	.074	-.388	.000	1.000

Table XV. Analysis [illegible] Plan

Orthogonal Factor Matrix, giving Factor loadings and communalities.

Variable No.	I	II	III	IV	Communality
2	-.246	.826	-.084	.000	.753
8	.606	-.290	-.394	.000	.607
9	.986	.000	.000	.000	.972
11	.352	-.289	-.053	.000	.210
14	.957	.000	.000	.000	.916
17	.980	.000	.000	.000	.960
[illegible]	.971	.000	.000	.000	.943
23	.779	.049	.589	.000	.956
[illegible]	.845	.120	.405	.000	.894
30	.691	.143	-.508	.000	.748
[illegible]	.932	.000	.000	.000	.869
33	.786	.152	.456	.000	.824
35	.578	.037	.721	.000	.859
39	.476	-.201	-.267	-.651	.762
50	.849	-.134	-.250	.000	.801
51	.515	.010	.559	.000	.578
[illegible]	.697	-.045	-.246	.000	.869
57	.058	-.361	-.977	-.630	.551
[illegible]	-.093	.039	-.810	.000	.667
72	-.177	.828	.084	.000	.724
73	-.338	.285	-.240	-.543	.548

Table XVIa Analysis II [illegible]

Rotated Matrix, giving rotated factor loadings and cosines of angles between factors.

Variable No.	Factors I	II	III	IV
[illegible]	.024	.752	-.077	.000
[illegible]	.026	-.234	-.362	.000
9	.707	.000	.000	.000
12	.234	-.257	-.049	.000
14	.687	.000	.000	.000
17	.704	.000	.000	.000
[illegible]	.697	.000	.000	.000
23	.204	.004	.548	.000
28	.378	.061	.373	.000
29	.826	.163	-.467	.000
[illegible]	.669	.000	.000	.000
32	.309	.106	.420	.000
36	-.024	-.016	.663	.000
39	.300	.116	.009	-.651
50	.740	-.104	-.230	.000
51	.026	-.029	.514	.000
56	.784	-.042	-.226	.000
57	-.144	-.068	.179	-.630
69	.438	.090	-.745	.000
72	-.030	.740	.077	.000
73	-.186	.506	-.008	-.543

Cosines of angles between Factors

	I	II	III	IV
I	1.000			
II	.092	1.000		
III	.672	.105	1.000	
IV	.263	-.428	-.391	1.000

Table XVIIa Analysis I [illegible]

Orthogonal Factor Matrix, giving factor loadings and communalities.

Variable No.	Factors I	II	III	IV	V	Communality
3	.533	.289	-.711	.016	.018	.874
6	.944	.213	.000	.000	.000	.937
10	.934	.224	.000	.000	.000	.933
11	.085	.276	.338	.770	.005	.790
14	.143	.415	.482	.689	-.006	.902
15	.983	.000	.000	.000	.000	.976
17	.972	.000	.000	.000	.000	.945
18	.983	.000	.000	.000	.000	.966
19	.954	.000	.000	.000	.000	.910
21	.974	.000	.000	.000	.000	.953
23	.986	.000	.000	.000	.000	.972
25	.961	-.222	.000	.000	.000	.973
27	.646	-.629	.000	.000	.000	.853
28	.729	.337	.035	.241	.500	.903
29	.722	.370	.025	.233	.490	.953
32	.361	-.575	.144	.179	.338	.668
34	.017	.620	.000	.000	.000	.790
37	.565	.690	.253	.090	.081	.874
38	.735	.569	.482	-.161	-.054	1.125
39	.965	.000	.000	.000	.000	.937
40	-.146	.093	.000	-.161	-.054	.059
42	.739	.455	-.263	.031	-.012	.821
43	-.077	-.121	-.770	-.084	-.004	.621
44	.569	.126	-.532	.074	-.015	.628

Table XVIIIa Analysis I Orthax

Rotated matrix, giving rotated factor loadings and cosines of angles between factors.

Variable No.	Factors I	II	III	IV	V
3	.036	.042	-.613	.006	.016
9	.356	.164	.000	.000	.000
10	.343	.173	.000	.000	.000
11	.029	-.097	-.088	.687	.005
12	-.048	.092	.074	.619	-.006
13	.533	.000	.000	.000	.000
14	.525	.000	.000	.000	.000
15	.530	.000	.000	.000	.000
16	.514	.000	.000	.000	.000
31	.529	.000	.000	.000	.000
32	.531	.000	.000	.000	.000
33	.676	-.171	.000	.000	.000
36	.819	-.494	.000	.000	.000
43	.013	-.007	-.003	-.006	.500
44	-.012	.023	-.010	-.011	.490
49	.611	-.612	.097	-.003	.365
56	-.127	.694	.000	.000	.000
57	-.186	.523	.186	.044	.061
58	.001	.651	.483	-.120	-.054
65	.521	.000	.000	.000	.000
67	-.159	.170	.070	-.120	-.054
68	.070	.276	-.242	.033	-.012
73	-.014	-.232	-.618	-.073	-.004
74	.208	-.061	-.194	.073	-.015

Cosines of Angles between Factors

	I	II	III	IV	V
I	1.000				
II	-.531	.995			
III	-.120	.396	1.000		
IV	.360	-.312	-.514	1.000	
V	-.380	-.308	.189	-.448	1.000

[illegible] Analysis of [illegible]

Orthogonal Factor Matrix, giving factor loadings and communalities.

Variable No.	I	II	III	IV	V	Communality
3	-.110	.[illegible]	-.034	.031	.000	.744
8	.842	.088	.101	.375	.000	.8[illegible]
10	.871	.[illegible]	.133	.387	.000	.929
11	.253	-.15[illegible]	.[illegible]92	.0[illegible]	.000	.[illegible]7
12	.362	-.170	.490	.1[illegible]	.000	.8[illegible]
13	.934	.000	.000	.000	.000	.[illegible]72
14	.835	.140	.099	.413	.000	.897
15	.768	.216	.156	.437	.000	.[illegible]82
16	.789	.357	.146	.417	.000	.85[illegible]
31	.965	.000	.000	.000	.000	.931
32	.959	.000	.000	.000	.000	.920
33	.963	.000	.000	.000	.000	.927
6	.651	.070	-.215	-.[illegible]	.367	1.05[illegible]
62	.354	.216	.[illegible]7[illegible]	.668	-.367	.97[illegible]
64	.429	.[illegible]69	.[illegible]37	.[illegible]64	.000	.[illegible]1[illegible]
69	.538	-.369	.134	.043	-.399	.661
72	.651	.059	.260	.536	.000	.75[illegible]
77	.553	.000	.438	.526	.000	.774
84	.408	.673	.275	.486	.000	.931
85	.957	.000	.000	.000	.000	.916
87	.023	-.006	.2[illegible]6	.088	.471	.291
89	-.337	.731	.266	.[illegible]13	.351	1.049
90	-.073	.[illegible]74	-.[illegible]07	-.3[illegible]7	.551	.820
91	-.153	.[illegible]5[illegible]	.03[illegible]	-.033	.000	.75[illegible]

Table XXa Analysis II CHEESE

Rotated Matrix, giving rotated factor loadings and cosines of angles between factors.

Variable No.	Factors I	II	III	IV	V
3	.010	.585	-.044	.038	.000
9	.611	-.036	-.07[illegible]	.36[illegible]	.000
10	.623	-.061	-.046	.373	.000
11	.026	.013	.782	-.036	.000
12	-.141	-.023	.713	.001	.000
13	.840	.000	.000	.000	.000
14	.597	-.013	-.028	.[illegible]	.000
15	.527	.0[illegible]	-.045	.421	.000
16	.552	.029	-.017	.[illegible]	.000
21	.868	.000	.000	.000	.000
32	.863	.000	.000	.000	.000
33	.866	.000	.000	.000	.000
36	.885	-.035	.060	-.[illegible]31	.367
[illegible]	.012	.2[illegible]	.110	.623	-.367
44	.087	.046	.7[illegible]	.04[illegible]	.000
45	.650	-.002	.[illegible]	.029	-.392
56	.3[illegible]	-.060	.023	.509	.000
57	.2[illegible]	-.093	.370	.481	.000
64	.226	.366	.040	.459	.000
65	.801	.000	.000	.000	.000
[illegible]	-.057	-.28[illegible]	.364	.066	.471
[illegible]	-.422	.203	.068	.415	.351
72	.201	.033	-.219	-.309	.551
7[illegible]	-.016	.61[illegible]	.045	-.036	.000

Cosines of Angles between Factors

	I	II	III	IV	V
I	.999				
II	.18[illegible]	1.002			
III	.001	.275	.999		
IV	-.359	-.3[illegible]	-.508	1.000	
V	.000	-.622	.000	.000	1.000

[illegible] XXI a Analysis I [illegible]

Orthogonal Factor matrix, giving factor loadings and communalities.

[illegible]	Factors I	II	III	IV	Communality
[illegible]	.245	.297	.007	-.015	.869
[illegible]	.467	.603	.617	.030	.963
[illegible]	.522	.071	.665	-.029	.752
[illegible]	.325	.005	.000	.000	.815
[illegible]	.970	.345	.000	.000	.962
[illegible]	.975	.071	.000	.000	.956
[illegible]	.960	-.028	.000	.000	.922
[illegible]	.279	-.113	.000	.000	.971
[illegible]	.592	-.504	.304	-.224	.834
[illegible]	.975	.071	.000	.000	.956
[illegible]	.647	.399	.000	.000	.873
[illegible]	.503	.518	.000	.024	.890
[illegible]	-.243	.299	-.543	-.259	.729
[illegible]	-.300	-.112	.017	-.749	.708
[illegible]	.585	.338	-.196	-.504	.776
[illegible]	.307	.271	-.211	-.263	.841
[illegible]	.785	.550	.000	.000	.919
[illegible]	.962	-.128	.000	.000	.947
[illegible]	-.351	.607	-.421	.362	.[illegible]
[illegible]	.761	.496	.000	.000	.795
[illegible]	-.067	.121	.427	-.070	.708
[illegible]	.444	.342	.375	.[illegible]7	.5[illegible]6

[illegible] Analysis I [illegible]

[illegible]tated [illegible]trix, giving rotated [illegible] of angles [illegible] factors.

Variable No.	Factors I	II	III	IV
1	.017	.319	.804	.0[illegible]
[illegible]	.06[illegible]	.[illegible]76	.[illegible]10	.072
[illegible]	.409	.052	[illegible]	-.012
[illegible]	.[illegible]3[illegible]	.507	.000	.000
10	[illegible]	.371	.000	.000
14	.725	.199	.000	.000
17	.75[illegible]	.103	.000	.000
20	.521	.019	.00[illegible]	.000
37	[illegible]	-.545	[illegible]	-.207
[illegible]	.72[illegible]	.199	.000	.000
[illegible]	.460	.500	.000	.000
[illegible]	.312	[illegible]	.56[illegible]	.17[illegible]
[illegible]	-.071	.229	.013	-.763
[illegible]	.06[illegible]	-.20[illegible]	.09[illegible]	.747
[illegible]	.444	.444	-.02[illegible]	-.[illegible]
[illegible]	-.05[illegible]	.519	-.07[illegible]	-.[illegible]
[illegible]	.337	.0[illegible]	.000	.000
[illegible]	.6[illegible]	-.018	.000	.000
67	-.25[illegible]	.06[illegible]	-.475	.337
[illegible]	.324	.5[illegible]	.000	.000
[illegible]	-.06[illegible]	.000	.830	-.024
75	.030	.362	.337	.377

Cosines of Angles
Between Factors

	I	II	III	IV
I	.990			
II	-.419	.999		
III	.065	-.133	1.000	
IV	-.358	.01[illegible]	-.065	.999

[illegible] CONDENSED, DRY AND EVAPORATED MILK

Orthogonal factor matrix giving factor loadings and communalities

Variable no.	Factors I	II	III	IV	V	Communality
1	-.140	.389	.851	.014	-.010	.[illegible]
4	-.074	.775	.615	-.052	.010	.987
5	.533	.220	.750	.053	.013	.89[illegible]
6	.004	.821	.281	.030	.072	.766
10	.921	.196	-.278	-.015	-.114	.976
14	.912	.236	.000	.000	.000	.887
18	.950	.158	.000	.000	.000	.[illegible]
20	.913	-.204	.000	.000	.000	.931
37	.490	-.623	.383	.164	.267	.[illegible]
40	.938	-.158	.000	.000	.000	.909
43	.688	.366	-.187	-.622	-.175	1.039
42	-.221	.761	.448	.072	.048	.836
46	.023	.260	.046	-.010	.852	.796
48	-.027	-.301	.131	-.176	.760	.717
54	.496	-.327	.065	-.163	.670	.[illegible]46
58	.287	.522	-.288	-.583	.176	.809
61	.494	.743	.000	.000	.000	.796
65	.902	-.227	.000	.000	.000	.865
67	.034	.061	-.321	-.056	-.155	.135
69	-.266	.866	.000	.000	.000	.821
72	-.124	.082	.838	-.015	-.013	.725
75	-.253	.655	.209	.156	-.165	.[illegible]

Table XXVa Analysis I CONDENSED, DRY AND EVAPORATED MILK

Rotated matrix using rotated factor loadings and cosines of angles between factors

Variable no.	Factors I	II	III	IV	V
1	-.012	-.006	.764	.013	-.010
4	-.007	.264	.577	-.051	.010
5	.644	.045	.054	.054	.013
6	.023	.477	.126	.037	.072
10	.459	.258	-.014	-.026	-.114
11	.007	.264	.000	.000	.000
16	.207	.223	.000	.000	.000
25	.075	.005	.000	.000	.000
27	.520	-.196	.132	.190	.267
28	.230	.032	.000	.000	.000
29	.639	-.115	.105	-.637	-.176
32	-.137	.373	.367	.070	.048
36	.007	.485	-.112	.008	.812
37	-.088	-.016	.043	-.098	.760
38	.502	.015	.003	-.111	.670
39	.247	.137	-.067	-.563	.176
44	.453	.512	.000	.000	.000
45	.458	-.011	.000	.000	.000
47	-.021	.027	-.239	-.071	-.155
48	-.301	.473	.000	.000	.000
2	.030	-.202	.764	-.016	-.013
35	-.240	.329	.161	.133	-.165

Cosines of Angles between Factors

	I	II	III	IV	V
I	1.001				
II	.048	1.001			
III	.162	-.555	.999		
IV	-.009	.660	-.104	1.000	
V	-.020	.410	-.108	.301	1.000

Table XXVa Analysis I PRODUCTION AND [illegible] OF DAIRY HERDS

Orthogonal Factor Matrix, giving factor loadings and communalities.

Variable No.	I	II	III	Communality
1	.893	-.309	-.005	.900
2	.[illegible]	-.808	[illegible]	.838
3	.962	.053	-.005	.928
4	.940	.039	-.132	.903
5	.748	-.003	.391	.599
6	.770	.538	.069	.893
7	.882	.110	.202	.[illegible]
[illegible]	.359	.767	-.319	.839
8[illegible]	.[illegible]	.954	-.004	.835
6[illegible]	.[illegible]	.688	-.[illegible]	.891
6[illegible]	.537	.567	.677	.806
73	-.378	-.786	-.095	.770
74	.679	.036	.687	.709
75	.659	.002	.306	.528
76	.[illegible]	.[illegible]	-.[illegible]	.875

Table XXVIa Analysis : PRODUCTION AND DISAPPEARANCE OF DAIRY PRODUCTS

Rotated Matrix giving rotated Factor Loadings and Cosines of Angles between Factors

Variable No.	Factors I	II	III
1	.594	-.358	-.031
.	.313	-.828	-.105
3	.563	.000	.125
4	.652	-.013	-.100
5	.274	-.044	.121
6	.439	.495	.034
7	.330	.063	.[illegible]
[illegible]	.020	.716	.[illegible]
[illegible]	.534	.004	.023
[illegible]	.507	.652	-.[illegible]
[illegible]	-.035	.536	.[illegible]
[illegible]	-.214	-.764	-.015
74	.000	-.001	.[illegible]
[illegible]	.121	-.034	.[illegible]
[illegible]	.472	.019	.[illegible]

Cosines of Angles between Factors

	I	II	III
I	1.003		
II	.064	1.003	
III	-.795	-.123	1.000

Table XVIIA Analysis II [illegible]

orthogonal factor matrix, giving factor loadings and communalities.

Variable No.	I	II	III	Communality
1	.923	-.078	-.[illegible]	.90[illegible]
[illegible]	.91[illegible]	-.0[illegible]	-.335	.8[illegible]
[illegible]	.9[illegible]	.030	.192	.9[illegible]
[illegible]	.9[illegible]	.068	.169	.8[illegible]
[illegible]	.623	-.[illegible]13	-.[illegible]	1.00[illegible]
[illegible]	.736	-.00[illegible]	.363	.[illegible]
[illegible]	.8[illegible]	-.[illegible]10	.204	.7[illegible]
[illegible]	-.165	-.05[illegible]	.715	.592
[illegible]	.8[illegible]	.[illegible]	.200	.7[illegible]
[illegible]	.[illegible]	-.[illegible]	.736	.7[illegible]
[illegible]	-.3[illegible]	-.[illegible]1[illegible]	.100	.669
[illegible]	.402	.197	-.103	.211
[illegible]	.703	.23[illegible]	.[illegible]25	.737
[illegible]	.577	.252	.270	.469
[illegible]	.610	-.09[illegible]	-.[illegible]36	.7[illegible]

Table XXVIIIa Analysis II [illegible]

Rotated Matrix, giving rotated factor loadings and cosines of angles between factors.

Variable no.	I	II	III
1	.537	.012	-.506
2	.920	.056	-.505
3	.914	.273	.096
4	.894	.256	-.001
5	.751	-.301	-.196
6	.729	.314	.216
7	.[illegible]	-.[illegible]	-.[illegible]
[illegible]	-.177	.[illegible]	.[illegible]
[illegible]	.782	.275	.031
[illegible]	.039	-.020	.[illegible]
[illegible]	.001	-.784	.146
73	.362	.236	-.143
74	.652	.433	.265
75	.525	.395	.144
76	.016	-.130	-.762

Cosines of Angles between Factors

	I	II	III
I	1.000		
II	-.003	1.000	
III	-.[illegible]	.15[illegible]	1.000

Table XXIXa Analysis I MARKETING MARGINS

Orthogonal Factor matrix giving factor loadings and communalities

Variable No.	Factors I	II	Communality
30	.978	-.064	.964
31	.926	.296	.945
32	.976	-.015	.955
33	.992	.072	.989
34	.917	-.222	.890
35	.693	.505	.722
36	.763	.570	.907
37	.692	.590	.827
52	-.184	-.101	.044
53	-.369	-.241	.194
64	.649	-.542	.833
65	.978	-.012	.957

Table XXXa Analysis I MARKETING MARGINS

Rotated matrix giving rotated factor loadings and cosines of angles between factors

Variable No.	Factors I	II
30	.672	-.040
31	.342	.337
32	.640	-.003
33	.569	.117
34	.743	-.161
35	.027	.535
36	.026	.604
37	-.034	.621
52	-.035	-.109
53	-.040	-.257
64	.906	-.612
65	.016	.032

Cosines of angles between Factors

	I	II
I	1.000	
II	-.756	1.000

Table [illegible] Analysis II [illegible]

Orthogonal Factor Matrix, giving factor loadings and communalities.

Variable No.	Factors I	II	Communality
30	.959	-.157	.942
31	.980	.252	.974
32	.929	-.266	.926
33	.963	.052	.930
59	.677	-.382	.543
60	.870	.300	.847
61	.713	.626	.900
[illegible]	[illegible]	[illegible]	[illegible]
52	-.028	-.387	.151
53	-.337	-.525	.390
64	.295	-.752	.662
65	.961	.130	.940

VIII. APPENDIX B

REGRESSION SYSTEMS FOR INDIVIDUAL DAIRY PRODUCTS

Table Ib. FLUID MILK AND CREAM

x_1 = total milk production
x_{19}= retail price of milk
x_{57}= real wholesale price of milk
x_{64}= real purchasing power advanced two months
x_{65}= consumer price index advanced one month
x_{76}= disappearance of fluid milk and cream

Regression System I 1920-1948

$$x_{76}= .303^{**}x_{65} + 1.061^{**}x_1 - .145^{**}x_{64} + .257^{**}x_{57}$$

$$r_{76.65,1,64,57}= .8642$$

$$r_{76.65,64,57} = .5783$$

$$r_{76.19,1,64,57} = .8412$$

Regression System II 1920-1941

$$x_{76}= .448^{**}x_{65} - .111x_{64} - .474^{**}x_{19} + .625^{**}x_1$$

$$r_{76.65,64,19,1} = .8768$$

$$r_{76.65,19} = .3749$$

**Two asterisks beside a number mean that in an infinite number of samples similar to this one, where the regression coefficient concerned was actually zero, a value larger than the one concerned here would be found in 1 percent of the cases.

Table IIb. CHEESE

x_3 = cheese production
x_{11} = milk-feed price ratio
x_{21} = retail price of cheese
x_{43} = real wholesale price of cheese at Chicago
x_{57} = real wholesale price of milk
x_{65} = consumer price index advanced one month
x_{74} = cheese disappearance

Regression System I 1929-1948

$$x_{74} = .283x_{65} - .190x_{57} + .781^{**}x_3 - .026x_{11} + .289x_{43}$$

$$r_{74.65,57,3,11,43} = .7468$$

$$r_{74.21,57,3,11,43} = .7511$$

$$r_{74.3} = .708$$

Regression System II 1929-1941

$$x_{74} = -.142x_{65} + .956^{**}x_3 - .026x_{11} + .054x_{43}$$

$$r_{74.65,3,11,43} = .7602$$

$$r_{74.21,3,11,43} = .7645$$

$$r_{74.3} = .750$$

** Two asterisks beside a number mean that in an infinite number of samples similar to this one, where the regression coefficient concerned was actually zero, a value larger than the one concerned here would be found in 1 percent of the cases.

Table IIIb. BUTTER

x_2 = butter production
x_{11} = butterfat-feed price ratio
x_{22} = retail price of butter
x_{51} = real retail price of oleomargarine
x_{64} = real purchasing power advanced two months
x_{65} = consumer price index advanced one month
x_{73} = butter disappearance

Regression System I 1929-1948

a. $x_{73} = -.681^{**}x_{65} + .262^{**}x_2 + .182x_{51} - .046x_{11}$

$r_{73.65,2,51,11} = .7727$

b. $x_{73} = -.276^{**}x_{65} + .287^{**}x_2 - .008x_{51} + .032x_{11} - .340^{**}x_{64}$

$r_{73.65,2,51,11,64} = .8330$

$r_{73.22,2,51,11,64} = .8306$

$r_{73.65,64} = .7854$

Regression System II 1929-1941

$x_{73} = .032x_{65} + .037x_{64} + .134^{**}x_2 - .175^{**}x_{51}$

$r_{73.65,64,2,51} = .5120$

$r_{73.22,64,2,51} = .5494$

$r_{73.51} = .383$

** Two asterisks beside a number mean that in an infinite number of samples similar to this one, where the regression coefficient concerned was actually zero, a value larger than the one concerned here would be found in 1 percent of the cases.

Table IVb. EVAPORATED MILK

x_1 = milk production on farms
x_{20} = retail price of evaporated milk
x_{46} = real wholesale price of evaporated milk
x_{55} = real wholesale price of dry skim milk
x_{64} = real purchasing power advanced two months
x_{65} = consumer price index advanced one month
x_{75} = evaporated milk disappearance

Regression System I 1929-1948

$$x_{75} = .086x_{65} + .155^{*}x_{64} + .596^{**}x_1 - .231^{**}x_{46}$$

$$r_{75.65,64,1,46} = .6342$$

$$r_{75.20,64,1,46} = .6325$$

$$r_{75.65,64} = .4836$$

Regression System II 1929-1941

$$x_{75} = -.532^{**}x_{65} + .879^{**}x_{64} + .262^{**}x_1 - .449x_{55} + .041x_{46}$$

$$r_{75.65,64,1,55,46} = .7150$$

$$r_{75.20,64,1,55,46} = .7249$$

$$r_{75.65,64} = .5943$$

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* One asterisk beside a number means that in an infinite number of samples similar to this one, where the regression coefficient concerned was actually zero, a value larger than the one concerned here would be found in 5 percent of the cases. Two asterisks mean they would be found in 1 percent of the cases.

IX. APPENDIX C

ORIGINAL DISAPPEARANCE DATA

Table Ic MONTHLY DISAPPEARANCE OF FLUID MILK AND CREAM [1]
(Million pounds)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1929	4,420	4,164	4,889	4,773	5,084	4,950	4,645	4,404	4,131	4,116	4,177	4,381	54,134
1930	4,472	4,271	5,037	4,971	5,214	5,335	4,873	4,489	4,137	4,256	4,380	4,488	55,923
1931	4,714	4,497	5,102	5,092	5,544	5,304	5,134	4,805	4,483	4,358	4,404	4,613	58,050
1932	4,797	4,595	5,151	5,060	5,480	5,483	5,286	4,672	4,529	4,595	4,514	4,643	58,805
1933	4,647	4,396	5,054	5,208	5,498	5,069	5,069	4,622	4,385	4,495	4,503	4,658	57,604
1934	4,536	4,207	4,817	4,975	5,195	5,177	4,785	4,409	4,211	4,199	4,199	4,379	55,089
1935	4,238	3,945	4,705	4,757	5,113	5,243	5,064	4,757	4,220	4,307	4,303	4,335	54,987
1936	4,260	4,206	4,806	4,974	5,279	5,254	5,106	4,397	4,046	4,126	4,160	4,383	54,997
1937	4,361	3,967	4,558	4,662	5,094	5,051	5,126	4,719	4,268	4,299	4,081	4,247	54,433
1938	4,207	3,913	4,668	4,730	4,964	5,102	4,985	4,484	4,157	4,194	4,163	4,239	53,806
1939	4,263	3,975	4,659	4,858	5,053	5,168	4,984	4,493	4,349	4,312	4,229	4,334	54,677
1940	4,226	4,031	4,742	4,710	5,003	5,293	4,857	4,482	4,284	4,281	4,285	4,316	54,510
1941	4,436	4,146	4,793	4,824	4,927	5,302	4,913	4,606	4,244	4,237	4,309	4,398	55,135
1942	4,548	4,159	4,766	4,857	5,034	5,488	5,277	4,949	4,720	4,690	4,689	4,798	57,975
1943	4,901	4,547	5,127	5,175	5,527	5,681	5,499	5,236	4,767	4,914	4,772	4,914	61,060
1944	5,074	4,941	5,353	5,352	5,586	5,787	5,716	5,286	4,917	5,136	5,036	5,263	63,447
1945	5,213	4,979	5,652	5,670	6,017	6,174	6,009	5,681	5,334	5,356	5,301	5,570	66,956
1946	5,559	5,255	6,080	6,021	6,739	6,811	6,122	5,673	4,961	4,912	4,940	5,054	68,127
1947	5,107	4,719	5,286	5,379	5,855	6,225	5,834	5,435	4,880	4,900	5,028	5,012	63,660
1948	5,142	4,961	5,293	5,387	5,823	6,142	5,902	5,313	4,871	5,015	4,895	5,011	63,755
1949	5,176	4,899	5,270	5,394	5,752	6,090	5,906	5,292	5,009	5,200	5,105	5,131	64,224
1950	5,380	5,075	5,417	5,593	5,780	6,056	6,073	5,507	5,218	5,351	5,316	5,449	66,214

1 Disappearance equals total production minus milk equivalent of manufactured products of butter, cheese, evaporated milk, condensed milk, dried whole milk, and ice cream.

X. APPENDIX D

TABLES OF SIMPLE CORRELATIONS BETWEEN VARIABLES

(Tables enclosed in attached pocket)

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Table Id. Analysis I Table of Simple Correlations between Variables 1929 - 1948

TABLE OF SIMPLE CORRELATIONS BETWEEN VARIABLES 1949 - 1968

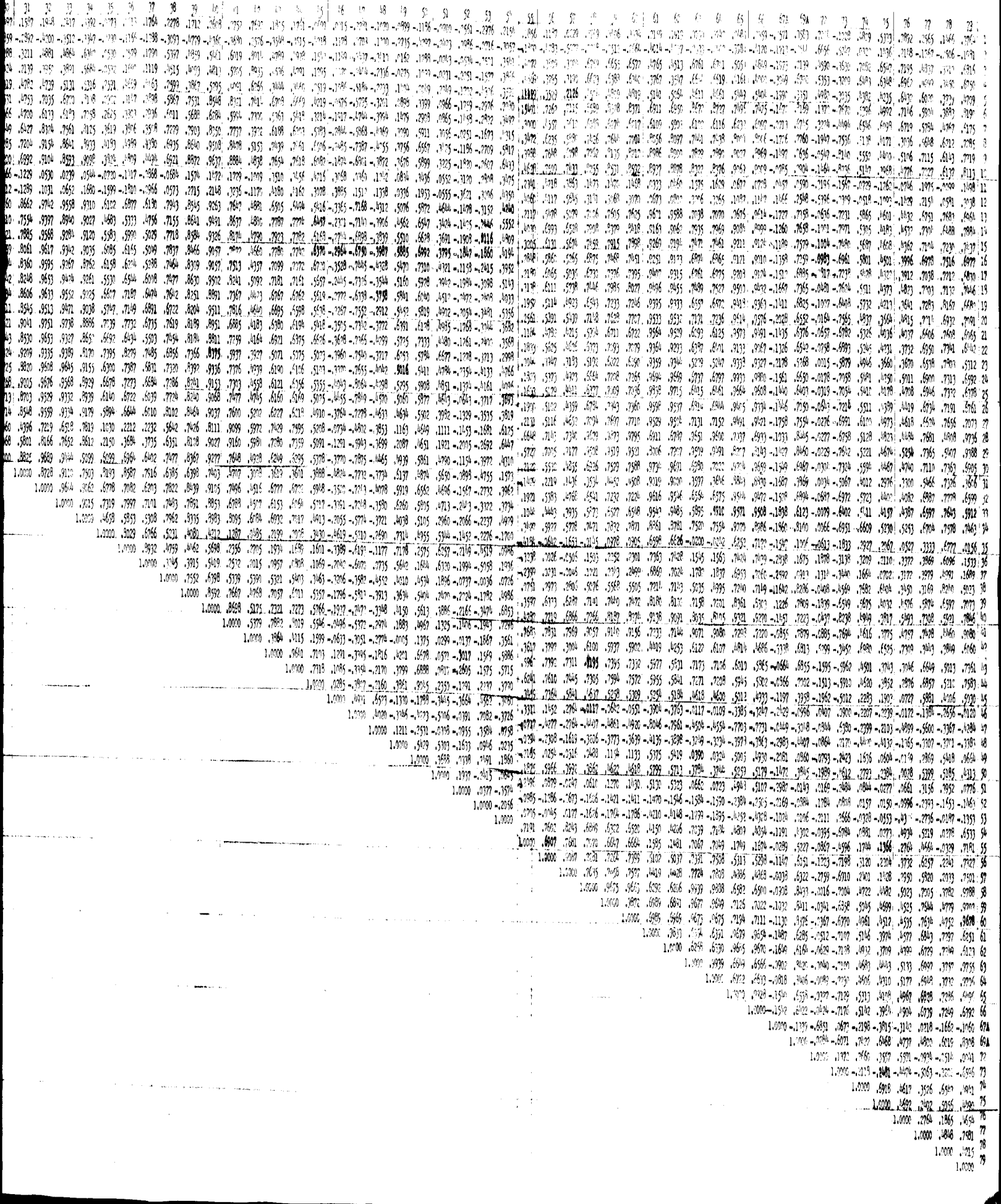

Table II d. Analysis II Table of Simple Correlations between Variables 1929 - 1941

II TABLE OF SIMPLE CORRELATIONS BETWEEN VARIABLES 1929 - 1941

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.0000	.9690	.8225	.8029	.6631	.5786	.7997	-.3964	-.2044	-.3029	-.2724	-.4171	-.1261	-.1771
2		1.0000	.8030	.7549	.6153	.5325	.7839	-.4133	-.2321	-.3362	-.2897	-.4278	-.1558	-.2243
3			1.0000	.9074	.5117	.7861	.8328	-.0667	-.0594	-.0971	-.1792	-.1987	-.0089	.0078
4				1.0000	.5243	.7596	.7450	-.0328	-.0353	-.0898	-.1747	-.2738	-.0203	.0516
5					1.0000	.4735	.6895	-.1393	.4103	.3277	.0331	-.2110	.4698	.4190
6						1.0000	.6213	.0782	.1105	.1314	-.0127	.0286	.1391	.2024
7							1.0000	-.1327	.1186	.0701	-.1219	-.2153	.2046	.1463
8								1.0000	.6393	.6034	.1974	.1693	.4908	.6106
9									1.0000	.9293	.3222	.1261	.8521	.9550
10										1.0000	.2933	.2384	.8975	.9511
11											1.0000	.8513	.1947	.2758
12												1.0000	.1159	.1459
13													1.0000	.8472
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	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	-.1135	-.1195	-.2282	-.0272	-.0751	-.0561	-.1050	-.1187	-.1262	-.0605	-.0852	-.1113	-.0494	.0970
2	-.1747	-.1706	-.2289	-.0792	-.1047	-.0928	-.1345	-.2433	-.1531	-.0847	-.1030	-.1457	-.0805	.0426
3	.1079	.0800	-.1324	.0429	.0522	-.1590	-.1616	-.1661	-.2391	-.1483	-.0993	-.0277	.1171	.4778
4	.1260	.1078	-.0985	.0949	.0359	-.1388	-.1444	-.1408	-.2163	-.1540	-.1188	-.0410	.1043	.4659
5	.4320	.4315	.4104	.5622	.5392	.5881	.5507	.4307	.4809	.5992	.5327	.4550	.4806	.3596
6	.2876	.2420	.0336	.2007	.2503	-.0308	-.0317	-.0219	-.1460	.0060	.0021	.0571	.2128	.6486
7	.2172	.2052	.1001	.2443	.2658	.1414	.1113	.0702	.0707	.1537	.1679	.1837	.2865	.4317
8	.5463	.5502	.5839	.4221	.4011	.1798	.2732	.5273	.2829	.1623	.3302	.5450	.5796	.5451
9	.8962	.9158	.9663	.8785	.8111	.7705	.8170	.9519	.7472	.7295	.8230	.8853	.9004	.6396
10	.9014	.9073	.9123	.8860	.8800	.7756	.8234	.8942	.7317	.7604	.8308	.8546	.8871	.6858
11	.3001	.3103	.3424	.2605	.2527	.1856	.2183	.3386	.1987	.2582	.1523	.1091	.0976	.1348
12	.1818	.1720	.1358	.1088	.2055	.0059	.0244	.1051	-.0004	.0994	-.0141	-.0687	-.0311	.1721
13	.7772	.7912	.8373	.8613	.9491	.8387	.8682	.8515	.8354	.8646	.8794	.8583	.8767	.5884
14	.9457	.9493	.9293	.9098	.8220	.7732	.8160	.9177	.7108	.7186	.8132	.8693	.9045	.7169
15	1.0000	.9746	.8741	.8545	.7644	.7077	.7645	.8362	.6287	.6594	.7581	.8241	.8681	.7497
16		1.0000	.9003	.8656	.7740	.7291	.7876	.8658	.6664	.6783	.7860	.8469	.8789	.7282
17			1.0000	.8600	.7999	.7960	.8318	.9586	.7725	.7538	.8367	.8813	.8773	.6758
18				1.0000	.8813	.8954	.8851	.8722	.7964	.8382	.8484	.8304	.8533	.6083
19					1.0000	.8215	.8382	.8056	.7731	.8753	.8397	.7813	.8258	.6311
20						1.0000	.9583	.8400	.8972	.9393	.9006	.8035	.7556	.3225
21							1.0000	.8814	.9222	.9435	.9446	.8604	.8032	.3570
22								1.0000	.8292	.8062	.8718	.8820	.8515	.4855
23									1.0000	.9112	.9089	.8492	.7353	.2206
24										1.0000	.9031	.7716	.7206	.3009
25											1.0000	.9047	.8444	.4071
26												1.0000	.9294	.5432
27													1.0000	.7225
28														1.0000

	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
1	.0918	-.0588	-.0267	-.1472	-.0401	.1161	-.1321	.1473	.0474	.1615	-.1617	-.1456	-.1706	.6998	-.1154	-.1069	-.7177
2	.0255	-.0835	-.0260	-.1769	-.0634	.0727	-.1314	.1400	.0260	.1414	-.1984	-.1789	-.1693	.6726	-.1581	-.1300	-.3556
3	.4238	-.0761	-.2282	-.0712	-.0965	.3145	-.3207	-.1990	-.3218	.5611	.0670	-.1788	.0923	.8110	.1611	.1785	-.1402
4	.4295	-.0845	-.2607	-.0662	-.1047	.2934	-.3303	-.1817	-.3016	.5503	.0516	-.1750	.1393	.8364	.2028	.2776	-.0919
5	.4574	.5475	.5100	.5125	.6023	.5188	.4980	.5335	.4117	-.1521	.0965	.5031	.2663	.3533	.2260	.2618	.1911
6	.6041	.0113	-.1896	.0913	.0519	.4794	-.2335	-.1991	-.3016	.5690	.2806	-.0006	.2462	.6622	.3639	.7741	.0585
7	.4280	.1859	.0782	.1701	.1847	.4372	.0138	.0950	-.0468	.3067	-.1045	.0619	.1632	.6054	.1498	.1715	-.0139
8	.4816	.3751	.0618	.4698	.1670	.3225	-.0367	-.3257	-.3366	-.3173	.3983	.2469	.5470	.0347	.3561	.4636	.5479
9	.6849	.8388	.5875	.9147	.7370	.6081	.5191	.2136	.1593	-.1115	.4752	.7865	.7594	-.1452	.5691	.6688	.7814
10	.7335	.8298	.5829	.9204	.7753	.6900	.5405	.2303	.1886	-.0600	.5560	.8303	.7785	-.1917	.5950	.6697	.7218
11	.2394	.1098	.0210	.2787	.2128	.2075	.1853	-.0316	.0255	-.0255	.2393	.2531	.0925	-.2172	.4657	.4545	.5283
12	.2512	-.0747	-.1636	.1222	.1069	.2508	.0308	-.1998	-.1021	.1823	.3104	.1003	.0675	-.2235	.4292	.3864	.3673
13	.6540	.8924	.7088	.9427	.8592	.7514	.6628	.4564	.3771	-.1209	.4605	.8176	.6043	-.0583	.3740	.4658	.3572
14	.7583	.8243	.5550	.8930	.7368	.6510	.4895	.2005	.1386	-.0503	.5027	.6138	.8298	-.1150	.6363	.7226	.7329
15	.7915	.7596	.4698	.8324	.6808	.6271	.4391	.1433	.0705	-.0024	.4928	.7640	.8047	-.0885	.7295	.7919	.6866
16	.7767	.7823	.4987	.8523	.6999	.6248	.4593	.1683	.1080	-.0352	.4855	.7858	.8115	-.1012	.7000	.7800	.7078
17	.6298	.8502	.6292	.9107	.7589	.5773	.5862	.2608	.2231	-.1982	.4182	.7935	.7289	-.2065	.5554	.6465	.8101
18	.6835	.8610	.6594	.9239	.8598	.7322	.8151	.4382	.4122	-.1637	.4417	.8630	.6984	-.0500	.5244	.6004	.6278
19	.7163	.8361	.6571	.9255	.8893	.8660	.6485	.4559	.3789	-.0760	.4881	.8034	.5667	-.0099	.4549	.5284	.5756
20	.1428	.9030	.8528	.8886	.9366	.5952	.8156	.7091	.6974	-.5087	.2800	.9158	.5246	-.2684	.2952	.3560	.4800
21	.4710	.9395	.8636	.9156	.9376	.5691	.8244	.6923	.6122	-.4933	.3062	.9524	.5644	-.2932	.3292	.4037	.4972
22	.5585	.8822	.7081	.9290	.8111	.5477	.6668	.3707	.3193	-.2954	.3941	.8453	.6800	-.2467	.4883	.5772	.7603
23	.3222	.9193	.8780	.8694	.8728	.4900	.8346	.6932	.6299	-.3211	.2546	.8569	.4614	-.3099	.1524	.2302	.4079
24	.4380	.8932	.8667	.8946	.9570	.6312	.8710	.7545	.6803	-.4870	.3024	.8985	.4110	-.2572	.2668	.3205	.4474
25	.4920	.9692	.8883	.9152	.9055	.5872	.7972	.6105	.5197	-.4249	.3310	.8921	.5875	-.2577	.2790	.3707	.4718
26	.5771	.9351	.7374	.8884	.7702	.5395	.6080	.3883	.2992	-.2450	.3453	.7901	.7018	-.1850	.3053	.4093	.4934
27	.7400	.8727	.6123	.8804	.7264	.6471	.5008	.2829	.1762	-.0416	.4167	.7440	.7560	-.0142	.4326	.5367	.5040
28	.9577	.4122	.0394	.5402	.3492	.7022	-.0151	-.2202	-.3094	.5414	.5505	.2771	.7144	.3690	.6555	.7165	.5050
29	1.0000	.4827	.1345	.6276	.4782	.7641	.1286	-.0742	-.1650	.4200	.5561	.4953	.6878	.3064	.6876	.7425	.5491
30		1.0000	.8880	.9262	.8882	.5817	.7792	.5970	.5142	-.3983	.3102	.8802	.6175	-.2064	.2474	.3444	.4713
31			1.0000	.7495	.8516	.3635	.8792	.7965	.7295	-.6821	.1013	.8013	.3400	-.3528	-.0417	.0312	.2424
32				1.0000	.9014	.7118	.7188	.4721	.4093	-.3350	.4471	.8726	.6450	-.1548	.4475	.5865	.6578
33					1.0000	.7032	.8537	.7196	.6564	-.4579	.3220	.9050	.4698	-.2153	.2993	.3579	.4688
34						1.0000	.3460	.2393	.1835	.2316	.4678	.5588	.4899	.2593	.4744	.5250	.4500
35							1.0000	.8008	.7366	-.6932	.1126	.7885	.2286	-.4210	.0754	.0987	.3080
36								1.0000	.9016	-.7471	-.0990	.6355	.0514	-.2626	-.2241	-.2011	-.0841
37									1.0000	-.7771	-.0775	.5761	-.0810	-.3343	-.2473	-.2391	-.0656
38										1.0000	.2496	-.4591	.1190	.6656	.3852	.2992	.0469
39											1.0000	.3328	.4356	.0840	.4722	.4886	.4208
40												1.0000	.6247	-.3136	.3959	.4507	.5055
41													1.0000	-.0087	.5930	.6511	.5716
42														1.0000	.0647	.1032	-.1129
43															1.0000	.9571	.7244
44																1.0000	.7784
45																	1.0000

II TABLE OF SIMPLE CORRELATIONS BETWEEN VARIABLES 1929 - 1941